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ERRATA.

- P. 3, line 24 from top of page, *for* homaloguous *read* homologous.
- P. 11, line 6 from top of page, *for* *Mitorhinus* *read* *Mitrorhinus*.
- P. 13, line 12 from top of page, *for* *Pseudacathinae* *read* *Pseudacanthinae*.
- P. 56, line 15 from top of page, *for* *euacadorensis* *read* *ecuadorensis*.
- P. 66, line 15 from bottom of page, *for* *euacadorensis* *read* *ecuadorensis*.
- P. 70, in the description of text-fig. VIII, 3, *for* *punctipectis* *read* *punctipectus*, and text-fig. VIII, 5, *for* *Eshscholtz* *read* *Eschscholtz*.
- P. 71, line 6 from top of page, *for* *Malagassalus* *read* *Malagasalus*.
- P. 86, line 10 from top of page, *for* *Epishenus* *read* *Ephisphenus*.
- P. 88, in the description of text-figs. XI, 2 and XI, 3, *for* *javanus* *read* *javensis*, and text-fig. XI, 4, *for* *lamellidens* *read* *lamellatus*.
- P. 89, line 19 from bottom of page, *for* *Acera us* *read* *Aceraius*.
- P. 92, line 21 from bottom of page and page 93, line 6 from bottom of page, *for* *occulidens* *read* *oculidens*.
- P. 93, line 3 from bottom of page, *for* *Trapezockilus* *read* *Trapezochilus*.
- P. 108, line 15 from top of page and page 109, line 8 from top of page, *for* **Brittain** *read* Britain.
- P. 115, line 13 from top of page, *for* Bonatao *read* Banahao.
- P. 117, line 5 from top of page, *for* Vissale *read* Viscaya, line 6, *for* Banalao *read* Banahao; and line 15 *for* *glabriventis* *read* *glabriventris*.

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[N.B.—An asterisk (*) preceding a line denotes a new variety or subspecies; a dagger (†) indicates a new species; a double dagger (‡) a new genus or subgenus; a double asterisk (**) a new family or subfamily; synonyms are printed in italics.]

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A Contribution towards the Revision
of the
Passalidae of the World.

By

F. H. GRAVELY, D.Sc.

Assistant Superintendent, Zoological Survey of India.



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(With Plate I.)

WHEN preparing my "Account of the Oriental Passalidae" (1914c) the lack of a representative collection of American and African forms prevented me from considering the relationship to other groups, borne by the Indo-Australian groups to which the Oriental forms belong. Shortly after the publication of that paper, however, the Passalidae collected by Mynheer J. R. H. N. Van de Poll were offered for sale. These were bought by the Trustees of the Indian Museum, who thereby added a particularly fine set of Indo-Australian species to their collection, together with much material for comparison from America and Africa. My thanks are due to them for the encouragement which they have thus given me to extend my investigations, so that they may include a study of the classification of the whole family.

I have further to thank Mr. G. J. Arrow for assistance in various forms, including the loan of specimens from the British Museum ; Mr. C. Holman-Hunt for material from the Malay Peninsula ; M. R. Vitalis de Salvaza for material from French Indo-China ; Mr. C. F. Baker for material from the Philippines ; and M. Guy Babault and Mr. G. E. Bryant for material from various localities.

Morphology of the Head.

The study of a general collection of Passalidae, from parts of the world other than the Oriental Region, at once throws light on the question of the morphology of the anterior part of the head, a question which seemed most difficult before. It confirms as true for most species of Passalidae the suggestion, made on p. 337 of my "Account of the Oriental Passalidae," that "the whole of the upper surface of the anterior part of the head between the supra-orbital ridges and in front of the frontal ridges is frons, the whole of the clypeus being doubled beneath this out of sight ;" but it shows that this is not true of all species, and that the groove which I supposed to represent the suture between the clypeus and frons is probably situated beyond the lateral extremities of the former plate.

The most primitive surviving forms of Passalidae appear to be included in the genera *Oileoides* and *Popilius*, as these are defined below ; and *Oileoides subrecticornis* (see fig. i, 1 on next page) may conveniently be taken as an example of them.

In this species the clypeus is not hidden, but is exposed as an extensive transverse plate above the labrum. The labrum is attached by a well developed membrane, which extends beneath it to the lower posterior margin of the clypeus, and not to its anterior margin.

Thus two parts of the clypeus may be recognised, namely, a dorsal free part and a ventral part closely opposed to the membrane uniting it to the labrum. The posterior part of the free surface of the clypeus is sunk in the anterior margin of the frons, the two plates being, however, separated by a well marked suture; and the posterior angles are united with the adjoining portions of the frons to form a pair of small tubercles. These tubercles are those to which the name "outer tubercles" was given in my previous paper, a name which may conveniently be retained for them.

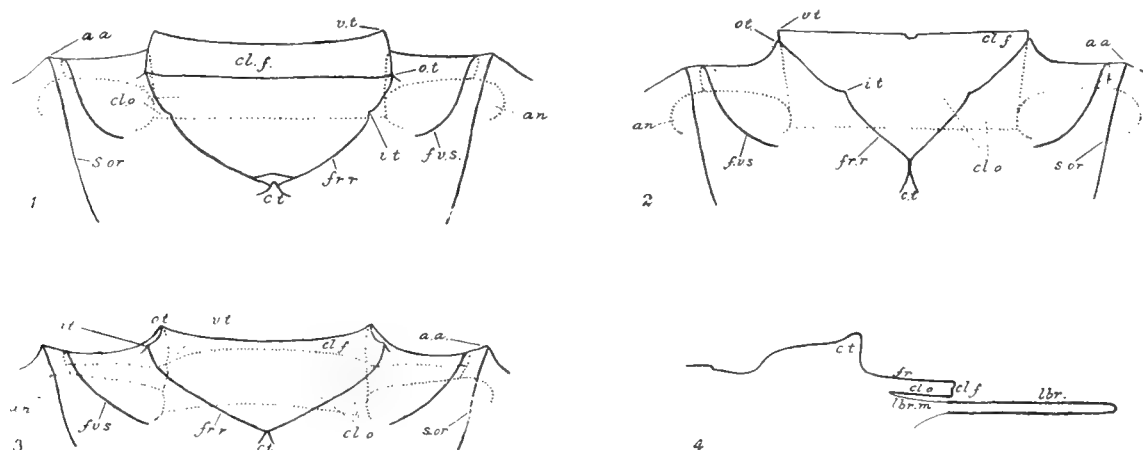


FIG. I.

1. *Oileoides subrecticornis* (Kuwert).
 2. *Chondrocephalus granulifrons* (Bates).
 3. *Passalus affinis*, Percheron.
 4. *Passalus affinis*, Percheron. Median section of upper and anterior parts of head.
- } Anterior part of head. The outlines of the plates of the upper surface indicated by continuous, and those of the lower surface by dotted, lines.

a.a.—anterior angles of head.
 an.—cavity for insertion of antenna.
 cl.f.—free surface of clypeus.
 cl.o.—opposed surface of clypeus.
 c.t.—central tubercle.
 fr.—frons.
 fr. r.—frontal ridge.

f.v.s.—frontovertical suture.
 i.t.—inner tubercle.
 lbr.—labrum.
 lbr.m.—membrane between labrum and clypeus.
 o.t.—outer tubercle.
 s.or.—supraorbital ridge.
 v.t.—ventral tubercle.

Having identified the clypeus in forms such as *Oileoides subrecticornis*, in which no doubt with regard to it can arise, the fate of the free surface of this plate in other forms can readily be followed.

In species belonging to the subfamily Pseudacanthinae (of this paper) the clypeus is always separated from the frons by a definite suture, though this varies greatly in shape and in some species the inner tubercles are situated so as to interfere somewhat with its continuity. In the Proculinae, in a few species of Passalinae, and perhaps also in the Aulacocyclinae, the clypeus has the same structure as in the Pseudacanthinae, but the suture is absent. In all other species the free surface of the clypeus is reduced to (at most) a narrow transverse band, situated below the anterior margin of the head, and terminated laterally by a pair of small downwardly directed tubercles, the "ventral tubercles" of my previous paper (1914c, text fig. i, p. 181). These "ventral tubercles"—really the anterior angles of the reduced free surface of the clypeus—are extremely persistent, and their presence or absence almost always enables one to determine whether the anterior margin of the head really conceals this surface of the clypeus or includes it. To see them clearly, however, it is often necessary to remove the labrum. The outer tubercles are normally situated immediately above or a little to the outer side of them; but in some forms these tubercles tend to come nearer together and may

be situated on the inner side of them. That they still mark the lateral extremities of the free surface of the clypeus in these cases is shown by the fact that they are joined by the sides of the opposed surface of the clypeus. The accompanying diagrams (fig. i) will help to illustrate the various stages in the suppression of the clypeus. With them may be compared figs. v, 11-15 and vi, 6-11 on pp. 34 and 45, illustrating in a less diagrammatic fashion its suppression in *Verres* and *Platyverres* and in *Paxillus* respectively.

The presence, in most American and African as well as Indo-Australian Passalidae, of definite frontal ridges and of central, inner and outer tubercles is sufficient indication of the morphological importance of these structures. The outer tubercles, as has just been shown, are formed in the more primitive species by a fusion of the frons and clypeus about the posterior angles of the latter. The central tubercle is normally situated at the angle formed by the union of the two frontal ridges which appear, from the evidence afforded by certain Indo-Australian species, to mark the position of part of the line separating the frons from the vertex. The inner tubercles appear to mark the point at which this line, usually quite imaginary for a short distance beyond this point, bends more or less backwards towards a suture a little to the inner side of the supraorbital ridges, in which it commonly ends (see Gravelly, 1914c, p. 184). This suture is easily seen in imperfectly hardened specimens of various groups, but is less distinct in those which have become thoroughly hard and black.

The homologies of the tubercles found in genera such as *Leptaulax* and *Tarquinius*, in which more than one pair of tubercles is situated on the anterior margin of the head, with those found in genera with only one pair so situated, are more difficult to determine than appeared to be the case when Indo-Australian forms only were under consideration.

A comparison of *Tarquinius* with *Pseudepisphenus* leaves little room for doubt that the more medially situated pair of tubercles in the former is homologous with the pair of inner tubercles of the latter (see Gravelly, 1914c, pp. 328-329), and in the absence of any evidence to the contrary it would be natural to assume the same homologies for the tubercles of *Leptaulax*, and of genera from the Ethiopian Region with similarly arranged tubercles.

But in the case of Ethiopian genera there is strong evidence in favour of different homologies. This is best illustrated by reference to the group characteristic of Madagascar, a group which is separated from the group found on the mainland of Africa by the possession of a pair of tubercles situated on the frons in the angle made by the fronto-vertical suture with the anterior margin of the head (see below pp. 68-69).

The most primitive of the Malagasy genera appears to be a new one described below (pp. 69-70, fig. viii, 1) under the name *Malagasalus*. In this genus the free surface of the clypeus, though almost vertical, is fully exposed. The outer tubercles, with a pair of well developed inner tubercles close behind them, project above it and are separated by a space equal to scarcely as much as two-thirds of its breadth. In *Solenocyclus*, the next genus of the series, the inner tubercles are also well developed and are situated further back from the outer tubercles; and an additional pair of marginal tubercles is present immediately above the ends of the clypeus. The outer tubercles, as pointed out above (p. 2), are formed in the first instance about the posterior angles of the clypeus; and their closer approximation one towards the other in forms such as *Malagasalus* leaves space in which the tendency towards tubercle-formation at this point can manifest itself over again. Presumably, therefore,

this additional pair of marginal tubercles is formed as a result of this tendency. *Solenocyclus* is too closely allied to *Pentalobus* and *Erionomus* to admit of any doubt as to the identity of the homologies of their cephalic tubercles. The cephalic tubercles of certain species of these however, bear the closest possible resemblance to those of the Indo-Australian genus *Leptaulax*; and there does not appear to be any conclusive evidence to show whether the homologies of *Leptaulax* are the same as those of *Tarquinius*, as previously suggested, or may not really be the same as those of *Erionomus*. In the former case the inner and outer pairs of marginal tubercles will be the true inner and outer tubercles respectively, and the rudimentary tubercles sometimes formed on the frontal ridges at the point where these bend forwards will be secondary structures. In the latter case these rudimentary tubercles will represent the true inner tubercles, the inner pair of marginal tubercles will be the true outer tubercles, and the outer pair of marginal tubercles will be secondary structures.

It was suggested in my "Account of the Oriental Passalidae" (p. 330) that the Leptaulacinae were of comparatively recent origin, and were still spreading from some distributional centre towards the middle of the Indo-Australian area, into the outlying parts of this area, such as the Indian Peninsula and Ceylon. If this is so—as all available evidence regarding their distribution seems to indicate—it is most unlikely that they are at all closely related to any but Indo-Australian groups, a suggestion whose correctness is confirmed by the fact that the anterior lower tooth in the Leptaulacinae is of a form found only in Indo-Australian groups (see below, p. 9). Presumably, therefore, the origin of the Leptaulacinae is to be sought among Indo-Australian forms. But there is no definite evidence to show that they are in any way related to *Tarquinius*, the only known Indo-Australian Passalid to which they bear even a superficial resemblance. The fact, moreover, that in most Indo-Australian forms the outer tubercles tend to be separated by a distance which is less than the width of the clypeus, makes it easy to suppose that the evolution of the Leptaulacinae may have been on lines parallel to those of the evolution of Ethiopian forms.

In view of this uncertainty as to the homologies of the cephalic tubercles in the Leptaulacinae it seems best to continue to use the terms "inner" and "outer" tubercles in the connection in which they were used in my previous paper; but in addition to insert the word "marginal," when speaking of the Leptaulacinae, in order to show that in this case the terms are used in a descriptive sense which is not necessarily in accordance with morphology.

Flightless Species.

In several groups of American and Indo-Australian Passalidae there are species which have lost the habit of flight. This tends in all cases to produce certain modifications of structure:—

1. The union of the lateral and intermediate areas of the metasternum.
2. The union of the elytra in the middle line.
3. The shortening of the elytra and the rounding of all their contours.
4. The reduction of the wings, which appear to become thereby more efficient stridulating organs.

Flightless species consequently tend to bear a strong resemblance to one another, especially as regards the general shape of the body, and Bates (1886, pp. 2-3) divided the American Passalidae into two sections on this character alone (see below, p. 6).

The extent of the modifications differs greatly in different species, and the relation which they bear one to another is not always the same. Thus in American species the union of the elytra tends to precede the modification of the metasternum, while in Indo-Australian species the reverse is the case. Similarly, reduction of the dentition, which seems to be to some extent associated in American groups with loss of the habit of flight (see below, p. 9) is only found in Indo-Australian forms (where it reaches its maximum development) among species which show no indication of this.

In the Indian *Pleurarius brachyphyllus*, in which the wings are fully developed, the union of the elytra is not indicated in the pupa and is imperfect or absent in the newly hatched adult. This appears to be the case in some other species also, and it seems likely that the elytra may remain separate throughout life in certain individuals. I have not seen pupae of any of the more highly modified species.

Genitalia and Sexual Distinctions.

Very little appears to be known of the genitalia of the Passalidae. Sharp and Muir (1912, pp. 579-580, pl. xlv, figs. 11-13a) found two forms of male genitalia to exist, one in which "the basal piece and the lateral lobes form one piece, either by consolidation or the suppression of the basal piece" and one in which "the tegmen consists of two distinct pieces, the basal piece and the lateral lobes." The former they found in the genus *Aulacocyclus*, the latter in all the other genera they examined; but their observations were very restricted. I have been able to add to these observations to some extent; but the results were not such as to warrant any extensive investigation, since all the genitalia examined proved to be very much alike, except in the Aulacocyclinae. Here both the types described by Sharp and Muir occur, one in one group of the subfamily and the other in the other, showing that the difference they found in *Aulacocyclus* is not a distinctive character of the Aulacocyclinae as a whole, as suggested in my previous paper (p. 191). The only other positive result of my investigations was a curious fact which emerged in connection with species in which the central tubercle varies greatly in size. In these it was found that the specimens in which it was largest and best developed were females, and not males as would be expected by analogy with other groups.

Classification, etc., including notes on the structure of the mandibles.

Although the Van de Poll collection is a remarkably fine one, it is by no means complete. There can, I think, be little doubt that a considerable number of described genera and species have no separate existence; but the absence from the collection of such distinctive forms as *Platyverres intermedius*, and of other well-known species, affords sufficient proof that the names of the missing forms are not all to be lightly relegated to synonymy. The number of new species in so incomplete a collection, on the other hand, seems clearly to indicate that the Passalidae of the world as a whole are less fully known than are those of the Oriental Region dealt with in my previous paper.

In order to prevent subsequent confusion I have redescribed, or have at least directed attention to the distinctive characters of, every species that I have seen, excepting only the Oriental ones described in my previous paper; and I have figured a large proportion of them. This is made essential by the unsatisfactory condition of most of the existing descriptions, a condition which has united with the incompleteness of the collection before me to make the compilation of a satisfactory synonymy of the species very difficult, if not impossible. No attempt has been made to deal with the synonymy of species, the references given being in all cases to original descriptions or to others on which I may have relied in making my determinations.

The forms dealt with in my "Account of the Oriental Passalidae" naturally receive less detailed treatment than the others. The keys to the determination of genera published in that work are, however, repeated with such alterations as further study has shown to be desirable; and, except in some of the smaller genera, keys have been given to the identification of all species known to me, although in a few cases these are practically identical with those already published.

The first serious attempts made to divide the Passalidae up into genera were those of Kaup in 1868-9 and 1871, respectively. In his "Monographie der Passaliden," published in the latter year, he set forth a remarkable conception of the Animal Kingdom, which led him to postulate a series of subdivisions into co-ordinated series of fives. Believing, as he did, that none of his five sub-families of Passalidae could contain more than five groups, that no group could be composed of more than five genera, and no genus of more than five species, and believing that corresponding species, genera and groups were to be found respectively in all or almost all genera, groups and sub-families, his system of classification inevitably led to a considerable amount of wide separation of closely related genera and species.

In 1886 Bates introduced a number of changes into Kaup's classification of the American species. He brought together in one section all those in which the elytra are relatively short, and more or less protuberant in the middle of the base, and into another all the rest—*i.e.*, those in which the elytra are moderately long with broadly emarginate base—subdividing each of these sections primarily according to the lengths of the antennal lamellae. Unfortunately for this classification the shape of the elytra is correlated with the modification of the wings for stridulation and the loss of the power of flight, changes which not only appear to have taken place in some of the most highly specialized forms of several different American groups, but are also found among widely separated Indo-Australian genera (see below, p. 125); and the lengths of the antennal lamellae rarely seem to have much phylogenetic importance, being more or less variable in a number of genera, perhaps in all (see also Gravely, 1914c, pp. 180 and 182).

Kuwert's elaborate "Passaliden dichotomisch bearbeitet" is still more lacking in any sense of phylogenetic values, and disregards in addition the facts of geographical distribution.

Zang and Arrow have done much useful work in the direction of clearing up various items of the confusion thus produced, and my "Account of the Oriental Passalidae" has, I hope, helped to reduce the classification of the forms with which it deals to order; but Kuwert's remains the most recent monograph of the Passalidae of the world. In my "Account of the Oriental Passalidae" I have recorded all references known to me relating to Oriental genera.

and species. The following appear to be the only forms not referred to either in Kuwert's work or there :—

A.—AMERICAN FORMS.

- Coniger*, n. gen. with *Rimor ridiculus*, Kuwert, as type, Zang, 1905c, p. 232.
Epiphoroneus, n. gen. with *Passalus occipitalis*, Eschscholtz, as type (Phoroneinae of Kuwert), Arrow, 1907, pp. 459–460.
Eumelus nasutus, Arrow, 1907, p. 459.
Nasoproculus, n. gen. with *Passalus heros*, Truqui, as type, Zang, 1905c, p. 226.
 „ *bifidus*, Zang, 1905c, p. 232, = *Oileus heros*, part, Kaup, nec *Passalus heros*, Truqui.
Neleides antillarum, Arrow, 1907, p. 452.
Neleus camerani, Pangella, 1905b, pp. 9–11.
 „ *cognettii*, Pangella, 1905b, pp. 13–15.
 „ *festae*, Rosmini, 1902, p. 8.
Ninus hondurae var. *rosminiae*, Pangella, 1905a, pp. 11–12.
 „ *nobilii*, Pangella, 1905b, pp. 5–7.
Paxillosomus alfari, Pangella, 1905a, pp. 9–11.
 „ *borellii*, Pangella, 1905b, pp. 3–4.
 „ *camerani*, Rosmini, 1902, pp. 4–5.
Paxillus parvus, Casey, 1897, pp. 644–645.
Petrejus archidona, Arrow, 1907, p. 456.
 „ *henrici*, Rosmini, 1902, pp. 6–7.
 „ *peruvianus*, Arrow, 1907, pp. 456–457.
 „ *spinosus*, Arrow, 1907, pp. 457.
Proculejoides crassulus, Casey, 1897, pp. 642–643.
 „ *granulipennis*, Zang, 1905a, pp. 229–231.
Proculejus nudicostis,¹ Bates, 1886–1890, p. 383.
Procululus, n. gen. with *P. inca*, n. sp. as type (Petrejinæ of Kuwert), Zang, 1905a, pp. 225–227.
Proculus beckeri, Zang, 1905a, p. 315.
 „ *densipennis*, Casey, 1914, p. 374.
 „ *mandibularis*, Casey, 1914, p. 374.
 „ *magister*, Casey, 1897, pp. 641–642.
Ptichopus borellii, Rosmini, 1902, p. 10.
Publius spinipes, Zang, 1905a, pp. 231–232.
Rhodocanthopus biolleyi, Pangella, 1905a, pp. 3–4.
Rimor munitus, Casey, 1897, pp. 643–644.
Soranus depressifrons, Bates, 1886–1890, pp. 384–385.
 „ *imbellis*, Casey, 1897, pp. 645–646.
Spurius conradi, Rosmini, 1902, p. 2.
 „ *dichotomus*, Zang, 1905a, pp. 227–229.
Tetraracus centralis, Arrow, 1907, p. 458.
 „ *nobilii*, Rosmini, 1902, pp. 5–6.
Triaenurgus solidus, Arrow, 1907, pp. 452–453.
Verres camerani, Pangella, 1905a, pp. 7–9, text fig.

¹ Zang, who knew it from the description only, placed this species in the genus *Proculejoides* (1905a, p. 229). According to Arrow this is incorrect (1907, p. 450). I have not seen a specimen, but the description shows it to have the tridentate mandibles and hairless elytra of the genus *Pseudacanthus* as this is defined below.

- Verres cavilabris*, Casey, 1897, pp. 646-647.
 „ *sternbergianus*, Zang, 1905a, p. 315.
 „ *verniscatus*, Casey, pp. 647-648.
Veturius isthmicus, Arrow, 1907, pp. 453-454.
 „ *peruvianus*, Arrow, 1907, p. 455.
 „ *punctatostriatus*, Arrow, 1907, pp. 454-455.

B.—ETHIOPIAN FORMS.

- Didymus congoensis*, Arrow, 1907, p. 463.
 „ *crassus*, Arrow, 1907, p. 465.
 „ *curvilineatus*, Arrow, 1907, pp. 462-463.
 „ *laevisternus*, Arrow, 1907, pp. 463-464.
 „ *latipunctus*, Zang, 1905a, pp. 315-316.
 „ *ruwenzoricus*, Arrow, 1907, pp. 464-465.
Erionomus platypleura, Arrow, 1907, p. 461.
Eumelosomus affinis, Arrow, 1907, pp. 465-466.
 „ *aloyssi sabaudiae*, Pangella, 1906, p. 1.

C.—INDO-AUSTRALIAN FORMS.

- Analaches bicavis*, Zang, 1905a, pp. 241-242.
 „ *brachymetopus*,¹ Zang, 1905a, pp. 30-31.
 „ *dubius*, Heller, 1910, pp. 20-21.
 „ *infestus*, Heller, 1910, p. 20.
 „ *laevigatus*,² Zang, 1903a, p. 339 ; and 1905a, pp. 29-30.
 „ *laticauda*, Zang, 1905a, pp. 240-241.
 „ *paraplesius*, Zang, 1905a, pp. 238-240.
 „ *punctithorax*,² Zang, 1903a, p. 339 ; and 1905a, pp. 28-29.
Aulacocyclus rouxi, Heller, 1916, pp. 352-353.
Cetejus acutangulus, Heller, 1910, pp. 18-19.
 „ *infans*, Heller, 1910, p. 18.
 „ *schenklingi*, Heller, 1910, pp. 19-20, text-fig. B.
 „ *sodalicus*, Zang, 1906b, p. 25.
Episphenoides pectiniger, Heller, 1910, pp. 17-18, text-fig. A.
Gonatas cetioides, Zang, 1905a, p. 316.
Hyperplesthenus glaber, Gravely, 1913, pp. 106-107, text-fig. 2A.
Kaupioloides, n. gen. with *Kaupiolus trigonophorus*, Zang as type, Gravely, 1913, pp. 103-105, text-fig. 1.
Kaupiolus trigonophorus, Zang, 1905a, p. 316.
Labienuus (?) *gracilis*, Heller, 1910, pp. 16-17.

¹ Subsequently transferred to the genus *Cetejus* (Zang, 1905a, p. 238, footnote).

² Originally named *Epilaches* owing to Kuwert's confusion of the two generic names (Zang, 1905a, p. 24) ; subsequently transferred to the genus *Cetejus* (Zang, 1905a, p. 238, footnote).

Mastochilus capitalis,¹ Blackburn, 1900, pp. 209-210.

.. *subobliquus*, Tryon, 1892.

Pelops triumphator, Zang, 1904b, pp. 182-184.

Plesthenus mandibularis, Heller, 1900, p. 11, pl. fig. 5.

.. *scutellopunctatus*, Zang, 1903a, p. 339.

Protomocoelus sternbergi, Zang, 1905a, pp. 236-238.

Tristorthus papuanus, Heller, 1910, p. 15, pl. figs. 15-15a.

Tristorthus puncticollis, Heller, 1916, p. 353.

In view of the striking correlation which has been shown to exist, in certain Indo-Australian Passalidae, between classification and distribution (Gravely, 1914b), it is natural, when seeking for sound principles on which to base the classification of the family as a whole, to consider first whether it may not be possible on purely morphological grounds to regard the American and Ethiopian Passalidae respectively as series independent both of one another and of Indo-Australian forms.

It will be remembered that among the Indo-Australian Passalidae the Aulacocyclinae stand by themselves, widely separated from all other forms (Gravely, 1914c, pp. 191-192). They are also widely separated from American and Ethiopian forms and need not be further considered in this connection. In all other Indo-Australian Passalidae, except certain highly asymmetrical ones with reduced dentition, the lowest terminal tooth is directed inwards and is situated beside the anterior lower tooth, which is broadly triangular as seen from above and tends to be flattened above and below. In American and Ethiopian forms, on the other hand, none of which are asymmetrical, either the terminal teeth are situated in a line one above another; or the anterior lower tooth (on the right side at least) is more columnar and tends to be flattened in front and behind, or may be concave behind much as it the Aulacocyclinae, or both characters may be present. These characters are more marked in some species than in others, but in greater or less degree they are of universal application; and they are associated with various other, often more striking, differences of more limited application.

The reduction of the dentition takes place mainly in highly specialized genera of the Indo-Australian and American series, genera whose relationships are, as a rule, clearly indicated by other characters. Among the former it is confined to the more highly asymmetrical genera, and among the latter it is found chiefly in genera composed wholly or in part of flightless species. It is easy to follow the manner in which the reduction is carried out in the former; but in the latter it is often more difficult, the reduction being more abrupt. In the Indo-Australian series it is always due to the fusion of the anterior lower tooth with the lowest terminal tooth (see Gravely, 1914c, text-fig. 7, p. 314). In the American and Ethiopian series, with the possible exception of the genus *Proculus*, it seems always to be due to the fusion of the two lowest terminal teeth, though this is apt to be accompanied by a dorsoventral flattening of the anterior lower tooth, which thus loses its distinctive shape.

The reduction of the dentition in the American and Ethiopian series may most conveniently be illustrated by reference to the genera of the *Proculejoides* group of Passalinae

¹ *Mastochilus capitalis*, Blackburn=*Episphenoides quæstionis*, Kuwert. See Zang, 1905c, p. 223.

(fig. ii, 1-3). In *Chondrocephalus* the dentition is normal, though the right anterior lower tooth is less distinctly columnar than usual. In *Vindex* the dentition is reduced, but the double origin of the lower of the two remaining terminal teeth may often be seen, especially in the right mandible of unworn specimens of *V. agnoscendus*. The anterior lower tooth of the left side is more conical in this genus, with dorso-ventral rather than antero-lateral compression, though that of the left side is still much broader than that of the right; and there is a more or less indistinct tubercle at the base of this tooth on both mandibles. In *Proculejoides* all trace of the double nature of the two remaining terminal teeth is lost, the anterior lower teeth of the two sides become still more alike, and the tubercles at their base become more conspicuous.

Of the genera with modified dentition in other families, *Proculejus* has teeth exactly like those of *Proculejoides*, and the only species of *Publius* known to me has teeth not unlike

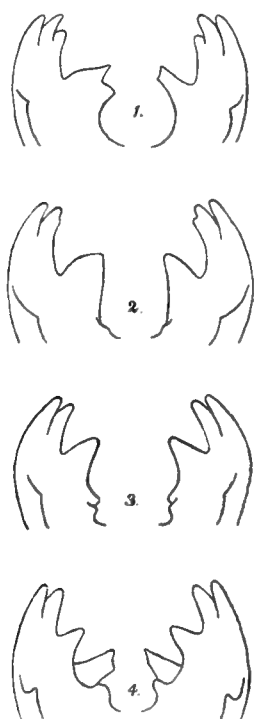


FIG. II.

1. *Chondrocephalus granulifrons* (Bates).
2. *Vindex agnoscendus* (Percheron).
3. *Proculejoides championi* (Bates).
4. *Proculus mnischechi*, Kaup.

The parts of the mandibles in front of and excluding the movable tooth, illustrating modifications in the dentition of American Passalidae.

those of *Vindex*, but has no trace on either side of the third terminal tooth and has more markedly asymmetrical anterior lower teeth. The teeth of *Proculus*, the most striking of all these genera, are, however, more puzzling. Superficially they usually resemble those of *Proculejoides*; but between what would be the anterior lower tooth in that genus and the large tubercle at its base there is ordinarily a scar, left by the breaking away of a columnar tooth which seems only to persist in imperfectly hardened specimens. This columnar tooth (see fig. ii, 4) has the form of the type of anterior lower tooth characteristic of the American series; and it is impossible to be sure whether the tooth in front of it forms the most anterior part of a single but highly complex anterior lower tooth, or is a lowest terminal tooth, reduced in size and situated behind and on the inner side of the middle and upper terminal teeth as in the Indo-Australian series.

The more typical American and Ethiopian forms can be distinguished from each other by the presence of one or more pairs, respectively, of marginal tubercles between the anterior angles of the head; but this distinction does not at first sight appear to be of universal application, since at least two genera, *Mitrorhinus* and *Stephanocephalus*, which have been accepted as American, have the additional tubercles characteristic of African genera. Zang, moreover, notes records of the American genus "*Passalus*" (= *Popilius* of the present paper) from the Congo, Senegal and Madagascar; and in the Van de Poll collection several specimens of *Pentalobus sansibaricus* bear the record "Bolivia"; while of two specimens of a new species of *Erionomus*, described below under the name *E. trichostigmoides*, one bears

the record "Dar-es-Salaam" and the other "S. Catherina, S. O. Brazil (Staudinger)." If these records are correct, and the species to which they refer really do occur both in America and in Africa or Madagascar, the occurrence in America of genera belonging to the group typical of Africa would be very natural. But in the absence of direct personal evidence by a collector I find it easier to believe them to be due to mistakes in labelling, numerous though they are. The position of *Mitorhinus* and *Stephanocephalus* therefore requires special consideration.

Judging from Kaup's figure (1871, pl. vi, fig. 3) *Passalus punctifrons*, Dejean, the type of the genus *Mitorhinus*, would seem to be from America and to belong in all probability, to the genus *Passalus* as this is defined below; but Kaup identifies the species with Percheron's *Passalus cayor*, a species the type of which is recorded as coming either from Senegal or from Brazil. As Percheron's figure (1835, pl. v, fig. 2) shows this to be an insect of the African type, the former is doubtless the correct locality. There can, I think, be little doubt that *cayor* belongs in reality to the African genus *Pentalobus*; and I suspect that both Kaup and Kuwert have confused prolongations of the anterior angles of the head with the tubercles on the inner side of these angles characteristic of African forms. Probably this has also been the case with the genus *Stephanocephalus*, the only species figured, Percheron's *Passalus hostilis* (1841, pl. lxxvii, fig. 4), whose locality was not known to its author, being in all probability African, although Kaup and Kuwert have applied the name to an American species, and have placed other American species in the same genus with it. For the present, then, the form of the anterior margin of the head may be regarded as separating American from Ethiopian groups; but further evidence on the point is much to be desired, especially as the aberrant genus *Ptichopus* is to some extent transitional between the two.¹

Another character by which the American and Ethiopian groups may be separated is afforded by the posterior plate of the prosternum. In the former this is usually more or less narrowed behind, and is often pointed; whereas in the latter it is always more or less parallel sided and broadly truncate. This plate has the African character in most species of the American genus *Paxillus*, but I know of no other exceptions to the rule, although the distinction is not equally well marked in all species.

The Ethiopian genera fall conveniently into a single subfamily Solenocyclinae. The American genera, on the other hand, fall into three groups, each in my opinion of sufficient size and distinctness for recognition as a separate sub-family.

The first of these, to which the name Pseudacanthinae may be given, is distinguished chiefly by the presence of a well marked clypeo-frontal suture. Traces of this suture are found also in the species described below under the name *Chondrocephalus quinquecornutus*, and it is more or less complete in *Vindex agnoscendus*. The former of these species may be regarded as in this character transitional between the two most primitive genera of the Pseudacanthinae and Passalinae respectively; and the latter agrees in every other character with the Passaline genus *Vindex* and not with any Pseudacanthine genus. In spite of these exceptions the presence of the suture in question remains the most distinctive single

¹ See also below, p. 13, footnote ¹.

character running through the Pseudacanthinae. The second American sub-family may be called the Proculinae. It includes forms in which the outer tubercles are rudimentary or absent; the clypeus is almost always exposed, though never separated from the frons by a distinct suture. The third and last American sub-family, the Passalinae, includes forms in which the outer tubercles are well developed and usually very widely separated, the clypeus being hidden in almost all species.

The classification of the Indo-Australian Passalidae was recently revised (Gravely, 1914c, pp. 191-204, 316-318 and 328-330). They fall into two distinct sections, of which one forms the sub-family Aulacocyclinae. The results of my previous work on the classification of the other section have been summarized as follows (1914c, pp. 336-337):—"The second section has been sub-divided into the *Pleurarius*, *Aceraius*, *Macrolinus*, *Kaupioloides*, *Protomocoelus*, *Hyperplesthenus*, *Gnaphalocnemis*, *Plesthenus*, *Gonatas*, *Tarquinius* and *Leptaulax* groups. Of these groups the first three and the last two appear to be of most importance, and have been provisionally ranked as subfamilies, the remainder being put together into a single subfamily which takes its name from the genus *Gnaphalocnemis*. Their rank cannot be finally settled without reference to American and African species."

The number of subfamilies thus recognized is undoubtedly too great in comparison with the classification of American and African forms outlined above, and may advantageously be reduced to two. One of these, the Leptaulacinae, remains as defined in my previous paper. The second, which may be called the Macrolininae, includes all the rest.

The above enumerated subfamilies of Passalidae may now be defined thus:—

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|---|---|--|--------------------------------|
| 1 | { | The distal ends of the anterior coxae projecting beyond the surface of the intercoxal portion of the prosternum, which is entirely hidden except in aberrant Chinese and Japanese forms, where it is exceptionally strongly keeled; the usual paired cephalic tubercles absent, the middle lower tooth almost always fixed | <i>Aulacocyclinae</i> , p. 13. |
| | | The distal ends of the anterior coxae about on a level with the general surface of the intercoxal portion of the prosternum, which is visible between them; at least one pair of the usual paired cephalic tubercles present in most species; the middle lower tooth always jointed on to the mandible | 2. |
| 2 | { | The anterior lower tooth more or less columnar, at least on the right side, being compressed before and behind or even concave behind; or all three terminal teeth directed forwards, and arranged in a line one above another; or the dentition incomplete; the head always symmetrical (American and African forms) | 3. |
| | | The anterior lower tooth conical, compressed above and below; the lowest terminal tooth directed inwards and set a little behind the other two; the head often asymmetrical—always so in forms with reduced dentition (Indo-Australian forms) | 6. |

- | | | | |
|----|---|--|--------------------------------|
| 31 | { | No secondary tubercles or angular processes present on the anterior margin of the head (or behind the clypeus when this is exposed) between the outer tubercles and anterior angles; the posterior plate of the prosternum almost always much narrowed, often pointed, behind (American forms) | 4. |
| | | At least one pair of secondary tubercles or angular processes present on the anterior margin of the head between the outer tubercles and the anterior angles; the posterior plate of the prosternum more or less parallel sided, broadly truncate behind (African forms) | <i>Solenocyclinae</i> , p. 68. |
| 4 | { | The clypeus exposed and separated from the frons by a distinct suture | <i>Pseudacathinae</i> , p. 22. |
| | | The clypeus fused with the frons ² and usually hidden | 5. |
| 5 | { | The outer tubercles obsolete or absent, the clypeus almost always exposed ³ | <i>Proculinae</i> , p. 32. |
| | | The outer tubercles distinct, the clypeus rarely exposed | <i>Passalinae</i> , p. 43. |
| 6 | { | The anterior margin of the head rarely with more than one pair of tubercles, ⁴ though these may be compound in structure; the antennae rarely with less than four well developed lamellae; never with both these characters | <i>Macrolininae</i> , p. 76. |
| | | The anterior margin of the head always with two pairs of simple tubercles; the antennae always with three well developed lamellae only | <i>Leptaulacinae</i> , p. 111. |

Subfamily *AULACOCYCLINAE*.

Three of the genera defined in my previous account of this subfamily (1914c, pp. 192-3) appear, in the light of further material, to be unnecessary. Two of these—*Caulifer* and *Auritulus*—are monospecific, and may advantageously be merged in *Aulacocyclus* and *Cylindrocaulus*, respectively. The third, *Tristorthus*, may also be merged in *Aulacocyclus*. The best known species of *Tristorthus* is *T. tricuspis*, Kaup, from New Caledonia, a species shown by its short antennal lamellae to be most nearly allied to the Australian species of *Aulacocyclus*. With this are associated firstly, two other New Caledonian species, apparently distinguished largely by differences in size, and in my opinion doubtfully

¹ The processes especially characteristic of the *Solenocyclinae* are situated immediately above the ventral tubercles. Others may also, however, be present, and in all Malagasy forms a pair is more or less distinctly developed immediately on the inner side of the fronto-vertical suture. The most primitive Malagasy genus, *Malagasalus*, lacks the former pair of processes, and the above definition is applicable only by reason of its possession of the latter. The African and Malagasy groups are composed, broadly speaking, of parallel series of genera separated largely by the presence or absence of the latter pair of processes. I do not know of any African genus paralleling *Malagasalus*; but if one exists the above definition can hardly be expected to apply to it. See also above, pp. 10-11.

² Except in one species of *Vindex* (below, pp. 43 & 47); imperfectly fused in one species of *Chondrocephalus* (below pp. 43-45, fig. vi, 1). See also above p. 11.

³ The clypeus is completely hidden only in the genus *Platyverres*, though in the transitional species *Verres corticola* it is hardly apparent. In both these species the inner tubercles are situated on the anterior margin of the head and may readily be mistaken for outer tubercles, though a comparison with other species of *Verres*, and especially with *V. cavicollis*, at once settles their true homology. The heads of the species in question are shown in fig. v, p. 34.

⁴ Only in the genus *Tarquinius*, which has six well developed antennal lamellae.

distinct; secondly, a species which Zang (1905c, p. 226) has shown not to be the Malaysian species for which Kuwert took it, but probably also a form of *tricuspis*; and thirdly, a species *felderi*, Stoliczka, from Amboina and Ceram, with a simply pointed central tubercle and long antennal leaflets like those of the Moluccan species of *Aulacocyclus*. The genus *Tristorthus* is thus seen to consist only of a New Caledonian species (or group of species) and a Moluccan species, allied respectively to different groups of the genus *Aulacocyclus*, in which I therefore propose to place them.

The genera of Aulacocyclinae may now be redefined thus:—

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|---|---|--|--------------------------------|
| 1 | { | The middle lower tooth fixed; the aedagus composed of two consecutive pieces, the tegmen and median lobe; ¹ the central tubercle always present near the middle of the upper surface of the head | 2. |
| | | The middle lower tooth moveable; the aedagus composed of three consecutive pieces, the tegmen being composed of a basal piece and lateral lobes; the central tubercle absent or occupying the whole of the antero-median part of the upper surface of the head | 4. |
| 2 | { | The mentum with a strong median keel | <i>Comacupes</i> , p. 14. |
| | | The mentum not keeled | 3. |
| 3 | { | The scars on the pronotum large, more or less ramified or S-shaped; the central tubercle broad and low, never pedunculate (Oriental forms only) | <i>Taeniocerus</i> , p. 16. |
| | | The scars on the pronotum not very large, crescentic or circular; the central tubercle taller, usually pedunculate (mostly not Oriental) | <i>Aulacocyclus</i> , p. 17. |
| 4 | { | The central tubercle present, often very strongly elevated, its apex fused with the anterior margin of the head; the elytra separate | <i>Ceracupes</i> , p. 21. |
| | | The central tubercle absent; the elytra united | <i>Cylindrocaulus</i> , p. 21. |

Genus **COMACUPES**, Kaup, 1871, p. 17.

Type, *Passalus cylindraceus*, Perty, 1831, p. 36, fig. 3.

Comacupes cylindraceus (Perty).

Passalus cylindraceus, Perty, 1831, p. 36, fig. 3.

Comacupes cylindraceus, Gravely, 1914c, p. 207, text-fig. 2, pl. xi, figs. 5-6a.

Specimens from the Malay Peninsula (Pahang), Singapore, North Nias (many from Hili Madjedja and one from G. Madjeja), Middle Nias (Dyma and Kalim Bungo), Sumatra (Bedagei interior, ca. 600 ft.), Java and Borneo (Mt. Marapok). Mr. C. Holman-Hunt has sent me for examination a specimen from Rawang in the Malay Peninsula. Length 24.5-27.5 mm.

¹ These names for parts of the male genital tube are those adopted by Sharp and Muir (1912, pp. 481-483 and 484-485).

Comacupes masoni, Stoliczka.*Comacupes masoni*, Stoliczka, 1873, pp. 151-2.*Comacupes masoni*, Gravelly, 1914c, p. 207, pl. xi, figs. 4-4a.

One specimen from an altitude of about 600 ft. in the interior of Bedagei, Sumatra, and three without locality label. They all resemble the Sumatran specimen referred to in footnote 2 of p. 269 of my "Account of the Oriental Passalidae." Without further specimens from the Malay Peninsula, however, it is impossible to say whether the Malay and Sumatran races of the species are distinct. Length 29-30 mm.

Comacupes stoliczkae, Gravelly.*Comacupes stoliczkae*, Gravelly, 1914c, p. 206, pl. xi, figs. 3-3a.

Two specimens from Djember, Besoek, Java; two from Mt. Marapol, Borneo; and two without locality label. M. Babault has sent a specimen 24.5 mm. long from Medan, Sumatra, for identification. Length 23.7-25.0 mm.

Comacupes basalis (Smith).*Passalus basalis*, Smith, 1852, p. 18, pl. i, fig. 5.

Five specimens from Mindoro and other parts of the Philippine Islands. Length 33.7-36.3 mm.

Comacupes cavicornis, Kaup.*Aulacocyclus cavicornis* + *laevicornis*, Kaup, 1868a, p. 6.*Comacupes cavicornis*, Kaup, 1871, p. 19.*Comacupes cavicornis*, Gravelly, 1914c, pp. 204-205, pl. xi, figs. 1-2b.

Several specimens from Singapore, Java (Tjibodas, Telaga Bodas in Garoet, Preanger) and Borneo (Pontianak). Length 24.5-26.0 mm.

These additional specimens show that the local races described in my "Account of the Oriental Passalidae" (pp. 204-206) are not constant, and must be treated as one.

The species of *Comacupes* may be identified thus:—

- | | | | |
|---|---|--|---------------------------------|
| 1 | { | The mesosternum strongly punctured all over; the abdominal sterna with at least a few hair-bearing punctures in fresh specimens | 2. |
| | | The mesosternum unpunctured except at the sides, the abdomen unpunctured and hairless | <i>C. foveicollis</i> , Kuwert. |
| 2 | { | The lower margin of the overhanging portion of the central tubercle short, or ascending obliquely to meet the upper margin, which is always horizontal; the tubercle usually truncate or concave anteriorly, not sharply pointed, narrower, keeled or rounded above | 3. |
| | | The lower margin of the overhanging portion of the central tubercle usually rather long, always horizontal, the anterior part of the upper margin descending obliquely to meet it in a more or less acute angle; the upper surface usually more or less distinctly grooved longitudinally, or excavate | 4. |

- | | | | | | | | | | |
|---|---|--|----|----|----|----|----|---------------------------------|--|
| 3 | { | The central tubercle not strongly elevated, truncate or concave | | | | | | | |
| | | in front, very variable | .. | .. | .. | .. | .. | <i>C. cylindraceus</i> , p. 14. | |
| 3 | { | The whole anterior end of the central tubercle raised well above | | | | | | | |
| | | the supraorbital ridges, not truncate or concave in front .. | .. | .. | .. | .. | .. | <i>C. masoni</i> , p. 15. | |
| 4 | { | The central tubercle marked above with, at most, a more or less | | | | | | | |
| | | distinct longitudinal groove | .. | .. | .. | .. | .. | 5. | |
| 5 | { | The central tubercle strongly excavate above | .. | .. | .. | .. | .. | <i>C. cavicornis</i> , p. 15. | |
| | | The central tubercle broad above, pedunculate | .. | .. | .. | .. | .. | <i>C. basalis</i> , p. 15. | |
| 5 | { | The central tubercle narrow, not pedunculate | .. | .. | .. | .. | .. | <i>C. stoliczkae</i> , p. 15. | |
| | | | | | | | | | |

Genus **TAENIOCERUS**, Kaup, 1871, p. 20.

Type, *Passalus bicanthatus*, Percheron, 1841, pp. 41-2, pl. lxxix, fig. 5.

Taeniocerus bicanthatus (Percheron).

Passalus bicanthatus, Percheron, 1841, pp. 41-42, pl. lxxix, fig. 5.

Taeniocerus bicanthatus, Gravely, 1914c, pp. 208-209, pl. xi, figs. 7-7b.

One specimen said, probably erroneously, to come from Ceylon; others from Penang, Singapore, Bintam Island, and Borneo (a number of specimens from Mt. Marapok in Dent Province, northern spurs of Mt. Kina-Balu, Labuan and Pontianak). Mr. C. Holman-Hunt has sent a specimen from Rawang, Malay Peninsula, for examination. Length 26.0-29.5 mm.

Taeniocerus platypus, Kaup.

Aulacocyclus platypus, Kaup, 1868a, p. 5.

Taeniocerus platypus, Kaup, 1871, p. 21.

Numerous specimens from Sumatra (Bedagei Interior, ca. 600 ft.), Java (Boeloe Lawang in Pasoeroean) and Borneo (Mt. Kina-Balu). M. Babault has presented us with specimens from Medan, Sumatra. Length 16.3-19.5 mm.

Taeniocerus pygmaeus, Kaup.

Aulacocyclus pygmaeus, Kaup, 1868a, p. 5.

Taeniocerus pygmaeus, Kaup, 1871, p. 20.

Taeniocerus pygmaeus, Gravely, 1914c, pp. 209-210, pl. xi, figs. 8-8a.

One specimen each from the Malay Peninsula and Sumatra (Bedagei Interior, ca. 600 ft.) and several from Borneo (two from Mt. Marapok, Dent Province). Mr. C. Holman-Hunt has sent specimens from Kuala Kansar, Malay Peninsula, for examination. Length 14.2-15.9 mm.

Taeniocerus bicuspis, Kaup.

Aulacocyclus bicuspis, Kaup, 1868a, p. 5.

Taeniocerus bicuspis, Kaup, 1871, pp. 21-22.

Taeniocerus bicuspis, Gravely, 1914c, pp. 210-211, pl. xi, figs. 9-9a.

Four specimens from Tukvar, Darjiling District, and one from "India." Length 18.5-21.1 mm.

The species of *Taeniocerus* may be identified thus :—

- | | | | | |
|---|---|--|--------------------------------|----|
| 1 | { | The upper surface of the central tubercle about twice as long as broad, flat, punctured, bordered by a very distinct horse-shoe-shaped ridge which is open in front | <i>T. bicanthatus</i> , p. 16. | |
| | | The upper surface of the central tubercle relatively broader as a rule, less flattened, unpunctured, the marginal ridge often indistinct or absent across the middle-line behind as well as in front | | 2. |
| 2 | { | The anterior tibiae very broad | <i>T. platypus</i> , p. 16. | |
| | | The anterior tibiae slenderer | | 3. |
| 3 | { | The anterior margin of the canthus meeting the side of the head at a considerable distance behind the anterior angle; the external angle of the canthus obtuse | <i>T. pygmaeus</i> , p. 16. | |
| | | The anterior margin of the canthus meeting the side of the head at a very short distance behind the anterior angle; the external angle of the canthus sharper | <i>T. bicuspis</i> , p. 16. | |

Genus **AULACOCYCLUS**, Kaup, 1868a, p. 4.

Incl. *Taeniocerus* [part] + *Caulifer*, Kaup, 1871 + *Tristorthus*, Kuwert, 1896, p. 220.

Type, *Passalus edentulus*, MacLeay, 1826, p. 439.

Aulacocyclus glabriusculus, Kuwert.

Aulacocyclus glabriusculus, Kuwert, 1897, pp. 280 and 282.

A number of specimens from Aru Island. Length 25.4–27.3 mm.

The antennal lamellae are long and slender; the central tubercle, which closely resembles that of *A. edentulus* (fig. iii, 7), is erect at base, oblique or almost horizontal above, where it is medially grooved, the apex scarcely or not at all bent downwards. The elytral grooves are shallow, and are scarcely punctured either above or below.

Aulacocyclus perlatus, Kaup.

Fig. III, 1, p. 18.

Aulacocyclus perlatus, Kaup, 1868a, p. 7.

Four specimens from New Guinea, three of them being from Stephansort, Astrolabe Bay. Length 19.5–21.6 mm.

The antennal lamellae are long and slender, as in the preceding species. The central tubercle is decumbent, and more or less distinctly bent downwards at the apex. All the grooves of the elytra are strongly punctured.

Aulacocyclus parryi, Kaup.

Aulacocyclus parryi, Kaup, 1868a, p. 8.

Represented by specimens from Ceram, Halmaheira (Dodinga), Ternate and Singapore. Length 23.2–25.3 mm.

The antennae and elytra resemble those of the preceding species. The central tubercle resembles that of *A. glabriusculus* and *A. edentulus*, but is inclined to be slightly thickened on the under side just at the apex, giving it a somewhat more hooked appearance.

Aulacocyclus aruensis, Kuwert.

Fig. III, 2.

Aulacocyclus aruensis, Kuwert, 1897, p. 282.

Two specimens from each of the following localities :—New Guinea, Jobi, Aru, Ceram. Length 21–25 mm.

The antennae and elytra resemble those of the two preceding species. The central tubercle somewhat resembles that of *A. deyrollei*, but is stouter and less elevated in front, and has the apex perhaps a little more distinctly overhanging than is usual in that species.

Aulacocyclus felderi (Stoliczka).

Fig. III, 3.

Comacupes felderi, Stoliczka, 1873, p. 152, footnote.*Comacupes felderi*, Arrow, 1907, p. 447.

One specimen from Amboina, and one from Honiteto, West Seran¹ (? Ceram). Length 21 mm.

This species differs from all others that are known in having the central tubercle ungrooved, erect, laterally compressed and simply pointed. The antennal lamellae are long

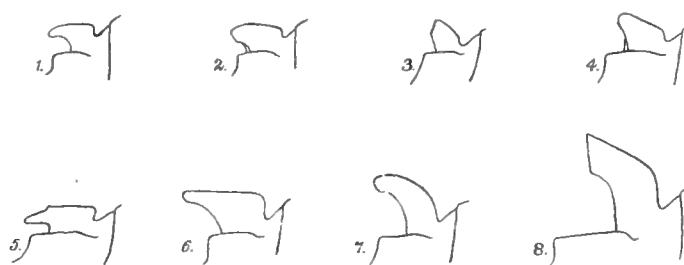


FIG. III.

The central tubercle and supraorbital ridge of species of *Aulacocyclus*, from the left side $\times 4$.

- | | |
|-----------------------------------|-----------------------------------|
| 1. <i>A. perlatus</i> , Kaup. | 5. <i>A. tricuspis</i> , Kaup. |
| 2. <i>A. aruensis</i> , Kuwert. | 6. <i>A. errans</i> , Blackburn. |
| 3. <i>A. felderi</i> (Stoliczka). | 7. <i>A. edentulus</i> (MacLeay). |
| 4. <i>A. mastersi</i> , MacLeay. | 8. <i>A. teres</i> (Percheron). |

and slender. The elytral grooves are scarcely punctured either above or at the sides, but are decidedly stronger than in *A. glabriusculus*.

Aulacocyclus mastersi, MacLeay.

Fig. III, 4.

Aulacocyclus mastersi, MacLeay, 1871, p. 174.*Taeniocerus mastersi*, Kuwert, 1897, p. 275.

Several specimens from Queensland (Port Denison and Clarence River), N. S. Wales (Richmond River) and Victoria. Length 21.7–27.5 mm.

The antennal lamellae are somewhat stout but moderately long. The central tubercle is laterally compressed and comparatively low. It is somewhat variable, and may be scarcely more elevated than in *Taeniocerus bicuspis*; usually, however, it is somewhat higher and the apex may even be faintly overhanging. The fine puncturing on the head is usually inconspicuous or absent. All the elytral grooves, except perhaps the first pair, are very finely punctured; none of them are very deep.

¹ "Exp. Martin III 92." Concerning the distribution of this species see Arrow, 1907, p. 447.

Aulacocyclus deyrollei, Kaup.*Aulacocyclus deyrollei*, Kaup, 1868a, pp. 7-8.*Taeniocerus deyrollei*, Kuwert, 1897, p. 275.

One specimen 25.5 mm. long, in the Indian Museum collection. I have also examined specimens in the British Museum.

A. deyrollei differs from *A. mastersi* only in the much greater breadth of the central tubercle and in the more conspicuous puncturing of the anterior part of the head.

Aulacocyclus tricuspis, Kaup.

Fig. III, 5.

Aulacocyclus tricuspis, Kaup, 1868a, p. 7.

Several specimens from New Caledonia and one from Woodlark Island. Length 22-25 mm.

This species is easily recognised by the tridentate form of the central tubercle, which resembles that of *Comapcupes cavicornis*, except that it is always broadest between the paired dorsal denticles. The antennal lamellae are much shorter than in *A. deyrollei*. The punctures in the grooves of the elytra are almost uniformly coarse.

Aulacocyclus errans, Blackburn.

Fig. III, 6.

Aulacocyclus collaris, Blackburn, 1896, p. 233.

Both sexes of this species appear to occur in two forms distinguishable from each other only by their size.

Large form.—Several specimens from Queensland. Mr. H. Schroder has presented us with specimens from the New England District of New South Wales. Length 27-30 mm.

Small form.—Numerous specimens from Queensland, including four from Cooktown, three from the McIvor River and one from Cardwell. Length 19.6-23.0 mm.

The antennal lamellae are somewhat shorter than in *A. deyrollei*. The central tubercle rises almost vertically and is then bent over forwards, the antero-ventral surface gradually and the postero-dorsal abruptly, the dorsal surface being straight and more or less horizontal. The anterior enlargements of the pronotal marginal grooves are somewhat more pronounced than in other species of the genus. The grooves of the elytra are even more coarsely punctured than in *A. tricuspis*.

Aulacocyclus edentulus (MacLeay).

Fig. III, 7.

Passalus edentulus, MacLeay, 1826, p. 439.

A number of specimens from Queensland (Brisbane), New South Wales (Sidney) and Victoria. Length 23-30 mm.

The central tubercle is more strongly elevated than in *A. errans* and less abruptly bent forwards. The anterior enlargements of the pronotal marginal groove are not very pronounced. The elytral grooves are less strongly punctured, especially dorsally.

Aulacocyclus teres (Percheron).

Fig. III, 8.

Passalus teres, Percheron, 1841, pp. 39-40.

A number of specimens from Queensland, New South Wales and Victoria (Melbourne). Length 30.8-40.0 mm.

A. teres is much larger than *A. edentulus*; its central tubercle is even more elevated, and is somewhat more abruptly bent forwards—scarcely as abruptly, however, as in *A. collaris*. The elytral grooves are very shallow and are obscurely punctured at the sides only.

The above-mentioned species of *Aulucocyclus* may be separated thus:—

- | | | |
|----|---|--|
| 1 | { | The antennal lamellae long and slender; Papuan and Moluccan species 2. |
| | | The antennal lamellae shorter, at most moderately long and slender; Australian and New Caledonian species (? also from Woodlark island) 6. |
| 2 | { | The central tubercle grooved above, its apex more or less overhanging 3. |
| | | The central tubercle not grooved above, its apex erect, laterally compressed and simply pointed <i>A. felderi</i> , p. 18. |
| 3 | { | The grooves of the elytra shallow and scarcely punctured <i>A. glabriusculus</i> , p. 17. |
| | | The grooves of the elytra deeper and more or less strongly punctured 4. |
| 4 | { | The central tubercle depressed, with slender overhanging apex <i>A. perlatus</i> , p. 17. |
| | | The central tubercle less depressed, with stouter or scarcely overhanging apex 5. |
| 5 | { | The apex of the central tubercle well developed, usually more or less hook-like <i>A. parryi</i> , p. 17 |
| | | The apex of the central tubercle short and stout, scarcely overhanging <i>A. aruensis</i> , p. 18. |
| 6 | { | The central tubercle very short, its apex scarcely or not overhanging 7. |
| | | The central tubercle more strongly elevated, with overhanging apex 8. |
| 7 | { | The central tubercle laterally compressed; the anterior part of the head not conspicuously punctured <i>A. mastersi</i> , p. 18. |
| | | The central tubercle very broad; the anterior part of the head somewhat strongly punctured <i>A. deyrollei</i> , p. 19. |
| 8 | { | The central tubercle pointed at apex as seen from above, with a pair of small tubercles beside the mid-dorsal groove behind <i>A. tricuspis</i> , p. 19. |
| | | The central tubercle normal, bifid at apex as seen from above 9. |
| 9 | { | The central tubercle moderately elevated and somewhat abruptly bent forwards; the elytral grooves very coarsely punctured <i>A. errans</i> , p. 19. |
| | | The central tubercle more strongly elevated and less abruptly bent forwards; the elytral grooves not very strongly punctured 10. |
| 10 | { | The central tubercle gradually curved forwards; the elytral grooves strongly impressed and distinctly punctured <i>A. edentulus</i> , p. 19. |
| | | The central tubercle somewhat abruptly bent forwards; the elytral grooves shallow and indistinctly punctured <i>A. teres</i> , p. 19 |

Genus **CERACUPES**, Kaup, 1871, p. 16.

Type, *Passalus fronticornis*, Westwood, 1842, pp. 124-125.

Ceracupes fronticornis (Westwood).

Passalus fronticornis, Westwood, 1842, pp. 124-125.

Ceracupes fronticornis, Gravelly, 1914c, p. 212, pl. xi, fig. 12.

Three specimens from 5,000-7,000 ft., Ruby Mines District of Upper Burma; two from Renong, Siam, and several without recorded locality. M. Vitalis de Salvaza has sent for examination a specimen from *ca.* 4,000 ft., Chapa, near Lao Kay, Ht. Tonkin; and Mr. J. Coggin Brown has presented us with a specimen from Loi Tawng Kyaw, Tawng Peng State, N. Shan States, Upper Burma, 5,500-7,000 ft.; and one from Man Pat, Mongmit State, 5,200 ft., Ruby Mines District, Upper Burma.

Length 20-23 mm.

This species is less distinct from *C. austeni* and *C. arrowi* than I supposed when drawing up the key to the species (1914c, p. 319), the shape of the central tubercle being very variable. The distinction given in that key between *C. austeni* and the present species appears to hold good, though the distal bifurcation of the central tubercle of the latter is sometimes very weak. The most distinctive difference between *C. arrowi* and the present species is found in the elytra, whose grooves are deeply impressed and coarsely punctured in the latter, but shallow and less strongly punctured in the former.

The species of *Ceracupes* may be identified thus:—

- | | | | | |
|---|---|--|---------------------------------|----|
| 1 | { | The grooves of the elytra, and their punctures, somewhat shallow | <i>C. arrowi</i> , Heller. | 2. |
| | | The grooves of the elytra, and their punctures, very deep | | |
| 2 | { | The apex of the horn formed by the fusion of the central tubercle with the anterior margin of the head more or less distinctly bifid | <i>C. fronticornis</i> , p. 21. | |
| | | The apex of this horn acute | <i>C. austeni</i> , Stoliczka. | |
| | | | | |

Genus **CYLINDROCAULUS**, Fairmaire, 1880, p. 164.

Incl. *Auritulus*, Zang, 1905.

Type, *Cylindrocaulus bucerus*, Fairmaire, 1880, p. 164.

The species of this genus may be identified thus:—

- | | | |
|---|---|--------------------------------|
| { | The front coxae almost contiguous; the canthus extending about half way across the eye; the supra-orbital tubercles flattened, expanded at the apex, truncate | <i>C. paialis</i> (Lewis). |
| | The front coxae widely separated; the canthus extending $\frac{3}{4}$ all the way across the eye; the supra-orbital tubercles slender and pointed | <i>C. bucerus</i> , Fairmaire. |

Subfamily PSEUDACANTHINAE.

The most extensive genus of this subfamily, and one of the most primitive, appears to be *Popilius*, a genus which, as limited by previous authors, has proved most difficult to define satisfactorily. None of the characters hitherto used for this purpose appear really to have more than specific value. Especially variable and untrustworthy, in many cases even as a specific character, is the shape and size of the central tubercle. Some of the most definite characters are found in the clypeus, but even these do not as a rule afford satisfactory generic distinctions. It seems necessary, therefore, to sink the names *Heliscus* (= *Soranus*), *Odontotaenius* (= *Passalus*, auct. nec Fabricius) and *Passalotaenius* as synonyms of *Popilius*. Similarly *Coniger*, *Rimor* and *Rimoricus* may be sunk as synonyms of *Oileus*. And both *Popilius* and *Oileus* must be redefined.

The plastic and primitive genus *Popilius* forms a starting point to which the remaining genera of American Passalidae may be traced back, the more primitive species of all the remaining subfamilies having the clypeus similarly exposed, although there is usually no clypeofrontal suture, and the more highly specialized having it hidden.

In the subfamily Pseudacanthinae itself three separate lines of evolution may be recognized. In one, which includes a new genus *Oileoides*, and the genera *Oileus* and *Undulifer*, the sides of the metasternum are broadly hairy. In another, which is represented only by the genus *Spurius*, the central tubercle is absent. In the third the elytra are united and the wings are of use for stridulation but not for flight.

The more primitive members of the third group have the three terminal teeth of the mandibles distinct as in *Popilius*. I have only seen three such species; these belong to the genera *Pseudacanthus*, *Triaenurgus* and *Nasoproculus*, in none of which are the sides of the elytra hairy. It will be convenient to unite these three genera, and with them should probably go the genera *Ogyges*, *Prosoclitus* and *Truquius*, which have hairless elytra — unfortunately their mandibles have not been described. *Petrejoides* should perhaps come here also, but Kuwert's definition is inconclusive, and I have nothing else to go by. The name may equally well be synonymous with *Proculejus* or even with *Proculejoides*.

The genera *Proculejus*,¹ *Prosoclitus*, and *Eriopterus* should likewise, in all probability, be united into one genus *Proculejus*, differing from *Pseudacanthus* in having only two teeth at the apex of the mandible instead of three and in having hairy sided elytra. The reduction in the number of teeth on the mandible probably takes place by the union of the two lowest terminal teeth. The anterior lower tooth appears broad and bidentate in this genus on both mandibles, instead of bidentate on the left and unidentate on the right as in allied forms of the preceding genus.

The genera of Pseudacanthinae may be defined thus:—

1	{	The elytra separate, their vertical anterior part lightly concave	..	..	2.
		The elytra united along the middle line, their vertical anterior part lightly convex	..	..	6.

¹ Except *P. quitensis*, Kaup (see below p. 51).

- | | | | |
|---|---|---|-------------------------------|
| 2 | { | The sides of the metasternum broadly hairy and punctured throughout | 3. |
| | | The hair-bearing punctures of the metasternum confined to the lateral areas and extreme anterior parts of the anterior intermediate areas | 5. |
| 3 | { | The clypeus transversely trapezoidal | <i>Oileoides</i> , p. 23. |
| | | The clypeus transversely linear, straight or undulating | 4. |
| 4 | { | The clypeus straight or lightly concave in the middle line .. | <i>Oileus</i> , p. 25. |
| | | The clypeus strongly convex in the middle and on either side, strongly produced backwards at the two points uniting the three curves thus formed | <i>Undulifer</i> , p. 25. |
| 5 | { | The central tubercle absent | <i>Spurius</i> , p. 26. |
| | | The central tubercle present | <i>Popilius</i> , p. 26. |
| 6 | { | The mandibles tridentate at apex, the left one with a broadly bifid tooth between the apex and the movable tooth, the right one with a unidentate tooth in this position (fig. iv, 13, p. 24); the sides of the elytra hairless | <i>Pseudacanthus</i> , p. 30. |
| | | The mandibles bidentate at apex, both of them with a broadly bifid tooth between the apex and the moveable tooth (fig. iv, 16, p. 24); the sides of the elytra hairy | <i>Proculejus</i> , p. 31. |

Genus **OILEOIDES**, n. gen.

Metasternum with a broad band of hair-bearing punctures on each side; clypeus expanded as in the more primitive species of *Popilius*. Otherwise like *Popilius*.

Type, *O. parvicornis*, n. sp.

Oileoides parvicornis, n. sp.

Fig. IV, 1, p. 24.

Two specimens from the Cauca Valley, Columbia. Length 27-28.5 mm.

The antennae have moderately long lamellae. The labrum is punctured and hairy, with distinctly concave anterior margin and convex sides, the latter somewhat convergent behind. Both mandibles have well developed upper, terminal and anterior lower teeth. The last-mentioned tooth is simple on the right side; on the left it is double, sometimes with the anterior of the two parts into which it is (vertically) divided itself divided to a less extent horizontally. The mentum is smooth in the middle, hairy and punctured laterally; its scars are not very strongly marked. The clypeus is extensive and flat like that of *Spurius bicornis* and *dichotomus*; it is lightly procurved as in the latter species. The frontal ridges are obsolete, and the central tubercle, though situated on the crest of a straight transverse ungrooved ridge formed by the union of the two parietal ridges, is very small. Between the central tubercle and the obsolete frontal ridges is a triangular area which is somewhat dull and strongly roughened, all the rest of the surface of the head being smooth and glossy.

The pronotum is transverse. The anterior margin is practically straight, the sides lightly and the posterior margin more distinctly convex. The scars are a little uneven, but are not definitely punctured. The prosternum is pointed behind.

The scutellum is smooth or distinctly but sparsely punctured. In the specimen in which the scutellum is unpunctured there is a strongly marked median groove; in the other this groove is much broken. The mesothoracic episterna are glossy and coarsely punctured all over, except in the posterior angles, which are matt and have less distinct or no punctures but may be more or less rugose. The mesosternum is more or less smooth and glossy all over—less so at the sides than in the middle.

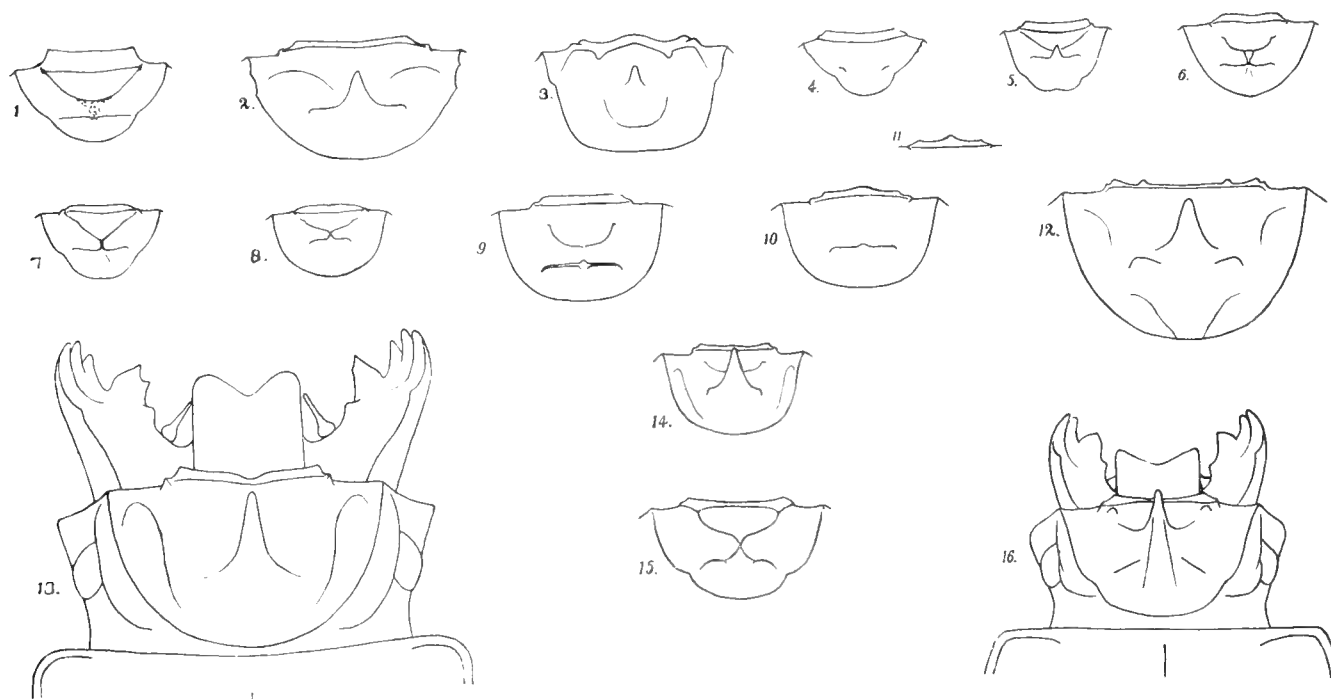


FIG. IV.

Pseudacanthinae; specific characters in the upper surface of the head $\times 4$.

- | | |
|--|--|
| 1. <i>Oileoides parvicornis</i> , Gravelly. | 9. <i>Popilius guatemalae</i> , Gravelly. |
| 2. <i>Oileus ridiculus</i> (Kuwert). | 10. <i>Popilius tropicus</i> (Percheron). |
| 3. <i>Undulifer incisus</i> (Truqui). | 11. <i>Popilius brevioripennis</i> (Kuwert). |
| 4. <i>Spurius dichotomus</i> , Zang. | 12. <i>Pseudacanthus solidus</i> (Arrow) |
| 5. <i>Popilius recticornis</i> (Burmeister). | 13. <i>Pseudacanthus bifidus</i> (Zang). |
| 6. <i>Popilius marginatus</i> (Percheron). | 14. <i>Pseudacanthus jalapensis</i> , Bates. |
| 7. <i>Popilius amazonicus</i> , Gravelly. | 15. <i>Proculejus sartori</i> , Kaup. |
| 8. <i>Popilius intergeneus</i> (Bates). | 16. <i>Proculejus pubicostis</i> , Bates. |

The lateral areas of the metasternum are narrow. These, the anterior intermediate areas, and the outer margins of the posterior intermediate areas are punctured and hairy. The rest of the plate is smooth, hairless and glossy, as are also the posterior coxae and the abdominal sterna. The grooves of the elytra are somewhat strongly punctured, especially laterally, but the punctures are small and round. The middle and hind tibiae are without spines except at the apex.

***Oileoides subrecticornis* (Kuwert).**

Soranus subrecticornis, Kuwert, 1897, p. 296.

Three specimens from the Cauca Valley, Columbia. Length 22-24 mm.

O. subrecticornis differs from *O. parvicornis* in its somewhat smaller size, its shorter antennal lamellae, its straighter clypeus, its somewhat more strongly developed central

tubercle and frontal ridges, which may be united and never have a roughened area between them, and its prothorax which is strongly punctured in and close round the scars.

Genus **OILEUS**, Kaup, 1869, p. 3.

Incl. *Coniger*, Zang, 1905 c; *Rimor*, Kaup, 1871; *Rimoricus*, Kuwert, 1897.

Type, *Passalus rimator*, Truqui, 1857, p. 266 (see Arrow, 1907, pp. 447-449.)

Species of this genus appear to be much larger than are those of the last, and further have always, so far as is known, a large decumbent central tubercle with free apex, instead of a feebly developed one, as well as a linear instead of an expanded clypeus.

Oileus ridiculus (Kuwert).

Fig. IV, 2.

Rimoricus ridiculus, Kuwert, 1897, p. 287.

Three specimens from Guatemala. Length 34-35 mm.

The lamellae of the antennae are extremely short, being equal to not more than two of the immediately preceding joints in length; the pronotum is punctured in and around the scars; the scutellum is roughened all over with obsolete punctures; the mesosternal scars are hairy; and the grooves of the elytra are very finely punctured. In one specimen the mesosternum is coarsely punctured.

Oileus sargi (Kaup):

Rimor sargii, Kaup, 1871, pp. 119-120.

One specimen from Guatemala. Length 30 mm.

The antennal lamellae are very long, being as long as about four of the immediately preceding joints; the pronotum is unpunctured; the scutellum is strongly punctured in the middle; and the mesosternal scars are not hairy.

Oileus rimator (Truqui).

Passalus rimator, Truqui, 1857, p. 266.

One specimen from Omilteme, Guerrero, 8,000 ft., lent by the British Museum. Length 37.8 mm.

This species is closely allied to *O. sargi*; from which it differs in having the clypeus lightly biconvex, the anterior margin of the pronotum biconcave and the mesosternal scars hairy.

Genus **UNDULIFER**, Kaup, 1869, p. 6.

Type, *Passalus incisus*, Truqui, 1857, pp. 266-267.

Undulifer incisus (Truqui).

Fig. IV, 3.

Passalus incisus, Truqui, 1857, pp. 266-267.

One specimen from Cordova, Mexico, presented by the British Museum. Length 29 mm.

Undulifer incisus is closely related to *Oileus ridiculus* and *sargi*. The antennae of the single specimen before me are broken, but from the one remaining lamella I conclude that

the lamellae were very long and slender as in the latter of these species. The clypeus has the form characteristic of the genus. The central tubercle is narrower and less separated from the surface of the head than in *O. ridiculus* and *O. sargi*. The pronotum is more extensively punctured round the scars than in either of these species. The mesothoracic episterna are polished throughout. The meso- and metasterna are extensively covered with hair-bearing punctures, especially laterally. The grooves of the elytra are quite as strongly punctured as in *O. ridiculus*.

Genus **SPURIUS**, Kaup, 1871, p. 75.

Type, *Passalus bicornis*, Truqui, 1857, p. 317.

Spurius bicornis (Truqui).

Passalus bicornis, Truqui, 1857, p. 317.

One specimen from Mexico and two from Guatemala. Length 17.5-18.0 mm.

Spurius dichotomus, Zang.

Fig. IV, 4, p. 24.

Spurius dichotomus Zang, 1905a, pp. 227-229.

One specimen from Guatemala, and one unlabelled preparation of the head and appendages. Length 21 mm.

This species may readily be distinguished from the preceding by its somewhat larger size; by the smaller size of the conical processes representing the parietal ridges, which are oblique instead of transverse; and by the shape of the clypeus, which is procurved instead of straight.

Genus **POPILIUS**, Kaup, 1871, p. 75.

Incl. *Heliscus*, Zang, 1905 (= *Soranus*, Kaup, 1871, preoccupied); *Odontotaenius*, Kuwert, 1896 (= *Passalus*, auct. nec Fabricius, see Zang, 1905c, pp. 224-225); *Passalotaenius*, Kuwert, 1896.

Type, *Passalus marginatus*, Percheron, 1835, pp. 89-90, pl. vii, fig. 1.

Popilius recticornis (Burmeister).

Fig. IV, 5, p. 24.

Passalus recticornis, Burmeister, 1847, pp. 508-509.

Four specimens from Mexico. Length 18-20 mm.

P. recticornis is the smallest species of its genus known to me. The antennal lamellae are short. The clypeus is strongly procurved. The frontal ridges are obsolete, but the central tubercle, which is directed forward, is very strongly developed, the apex being free. Apart from some of these characters, and the smoothness of the metasternum characteristic of the genus, *P. recticornis* closely resembles the above described species of the genus *Oileoides*. The mesothoracic episterna are, however, less extensively punctured and uniformly glossy, and the prosternum is truncate behind. The punctures round the scars on the pronotum are usually more numerous even than in *O. subrecticornis*.

Popilius marginatus (Percheron).

Fig. IV, 6, p. 24.

Passalus marginatus, Percheron, 1835, pp. 89-90, pl. vii, fig. 1.

Three specimens from Farinas, Bolivia. Length 21-22 mm.

Popilius marginatus is of about the same size as *Oileoides subrecticornis* or a little smaller, but it has longer antennal lamellae, its straight clypeus is less extensive antero-posteriorly and consequently less flat, there is a strong median keel or pair of keels between the small central tubercle and the obsolete frontal ridges, the pronotum is more thickly punctured above the scars and its median groove is complete, the scutellum is strongly punctured at least near the middle line in front. The metasternum resembles that of *P. recticornis* and other species of *Popilius*; it may have a few punctures in the posterior intermediate areas. The abdominal sterna are punctured in the angles of the scars. In other respects *P. marginatus* resembles *O. subrecticornis*.

Popilius amazonicus, n. sp.

Fig. IV, 7, p. 24.

One specimen from the Amazon, Peru. Length 20 mm.

P. amazonicus resembles *P. marginatus* in general appearance, but the tubercles and ridges of the head resemble rather those of *P. intergeneus*, the pronotum is very sparsely punctured near the scars, the pointed posterior extremity of the prosternum is very slender, and the scars of the abdominal sterna are more extensively punctured.

Popilius intergeneus (Bates).

Fig. IV, 8, p. 24.

Soranus (?) intergeneus, Bates, 1886, p. 21.

Numerous specimens from Guatemala. I am indebted to Mr. Arrow for their identification by comparison with Bates' type. Length 20.0-21.5 mm.

This species is intermediate in size between the two preceding. From *P. marginatus* it differs in having the antennal lamellae short, the anterior margin of the clypeus slightly convex and often indented in the middle line, the frontal ridges stronger and on an average more directly united with the central tubercle, the pronotum punctured in the anterior angles as well as above the scars, the prosternum truncate instead of pointed behind, the mesothoracic episterna uniformly glossy except for an unpunctured matt oval patch a little below and in front of the unpunctured posterior angles, the scars of the abdominal sterna more extensively punctured and the grooves of the elytra more strongly punctured.

Popilius guatemalae n. sp.

Fig. IV, 9, p. 24.

One specimen from Guatemala. Length 28.5 mm.

This species differs from *P. intergeneus* in its much larger size, straight margined clypeus, smaller and more arcuate frontal ridges, grooved parietal ridges, incomplete pronotal median groove, much less extensively punctured pronotum (the punctures being confined to the neighbourhood of the scars), pointed posterior end of prosternum, almost

unpunctured scutellum (the punctures being confined to a pair of longitudinal lines), normal mesothoracic episterna with matt and indistinctly punctured posterior angles, smoother abdominal sterna, and more finely punctured elytral grooves.

Popilius tropicus (Percheron).

Fig. IV, 10, p. 24.

Passalus tropicus, Percheron, 1835, pp. 97-99, pl. vii, fig. 4.

Five specimens from Mexico, and one without locality record. Length 25(♂)-28(♀) mm.

Kaup recognizes three varieties of this species, based on the sculpture of the upper surface of the head, and quotes Truqui to the effect that the central tubercle is very variable. One of the specimens before me has a much more strongly developed central tubercle than the others. It is a female and all the others are males¹.

The clypeus appears always to be distinctly recurved, and I doubt whether the frontal ridges, which are often absent, are ever very strongly developed. They are straighter than in *P. guatemalae*. The parietal ridges are not grooved, and the scutellum may be irregularly punctured. In other respects this species resembles *P. guatemalae*.

Popilius brevioripennis (Kuwert).

Fig. IV, 11, p. 24.

Odontotænius brevioripennis, Kuwert, 1897, p. 290.

One specimen from Mexico, distinctly smaller than the type (23 instead of 26 mm. long) and with numerous punctures above the scars. The number of these punctures is, however, very variable in the closely allied species, *P. striatopunctatus*, and the difference in size is within the usual limits of variability. The specimen of *P. brevioripennis* differs from the single female specimen of *P. tropicus* before me in having longer antennal lamellae, a strong median convexity of the anterior margin of the clypeus, a slightly truncate posterior prosternal plate, mesothoracic episterna like those of *P. intergeneus*, and more strongly punctured elytral grooves.

Popilius striato-punctatus (Percheron).

Passalus striato-punctatus, Percheron, 1835, pp. 101-102, pl. vii, fig. 7.

Numerous specimens from Mexico, one from British Honduras and two from Nicaragua. Length 25-28 mm.

The size of the central tubercle is variable; it is smaller in males than in females, but the difference is not a sharp one. *P. striatopunctatus* differs from *T. brevioripennis* in its larger size, its more strongly developed central tubercle and slightly less indistinct frontal ridges. The posterior end of the prosternum is variable.

Popilius cornutus (Fabricius).

Passalus cornutus, Fabricius, 1801, p. 256.

Numerous specimens from Florida, two from Mexico and one from each of the following places:—New York, Illinois, Delaware (Wilmington), Ohio and Haiti. Length 29-37 mm.

¹ In one the genitalia were found to be damaged, and I was unable to determine the sex with certainty.

The central tubercle is very variable in shape and size, and is larger in females than in males. *P. cornutus* differs from *P. striatopunctatus* in its larger size, somewhat shorter antennal lamellae, evenly arched anterior margin of clypeus, pedunculate and larger central tubercle, unpunctured pronotum, prosternum usually more broadly truncate behind, mesothoracic episterna with a broad matt band parallel to but not in contact with the lower margin, unpunctured posterior intermediate areas of metasternum, and more finely punctured elytral grooves.

The above species of *Popilius* may be distinguished from one another thus :—

- | | | | |
|---|---|--|--------------------------------------|
| 1 | { | The clypeus more or less broadly flattened and trapezoidal | 2. |
| | | The clypeus transversely linear or distinctly prominent in the middle line | 7. |
| 2 | { | The central tubercle elongate, with free forwardly directed apex | <i>P. recticornis</i> , p. 26. |
| | | The central tubercle small, its apex not free | 3. |
| 3 | { | The antennal lamellae long, equal to about four of the immediately preceding joints in length | 4. |
| | | The antennal lamellae short, equal to about two of the immediately preceding joints in length | 5. |
| 4 | { | The frontal ridges short and curved, together forming almost a semi-circle | <i>P. marginatus</i> , p. 27. |
| | | The frontal ridges long and approximately straight, meeting in a slightly obtuse angle | <i>P. amazonicus</i> , p. 27. |
| 5 | { | The central tubercle situated in, or a little in front of, the middle of the head; the frontal ridges well developed, long and approximately straight, meeting in an obtuse angle | <i>P. intergeneus</i> , p. 27. |
| | | The central tubercle situated a little behind the middle of the head; the frontal ridges weaker or absent | 6. |
| 6 | { | The clypeus straight; the frontal ridges forming a semi-circle in front of the central tubercle; the parietal ridges grooved | <i>P. guatemalae</i> , p. 27. |
| | | The clypeus lightly recurved; the frontal ridges absent, or extending straight to the obsolete frontal tubercles from either side of the base of the central tubercle at about a right-angle to each other; the parietal ridges keeled | |
| 7 | { | The clypeus linear, parallel-sided, lightly recurved; the central tubercle sometimes with free apex, but never pedunculate | <i>P. tropicus</i> , p. 28. |
| | | The clypeus with at least the posterior margin straight; or the central tubercle pedunculate | 8. |
| 8 | { | The anterior margin of the clypeus with a strongly developed median convexity, the central tubercle not pedunculate | 9. |
| | | The anterior margin of the clypeus at most lightly convex medially, the central tubercle pedunculate | <i>P. cornutus</i> , p. 28. |
| 9 | { | The central tubercle of moderate size, its apex scarcely free | <i>P. brevioripennis</i> , p. 28. |
| | | The central tubercle large in both sexes (especially the female), its apex entirely free | <i>P. striato-punctatus</i> , p. 28. |

Genus **PSEUDACANTHUS**, Kaup, 1869, p. 9.

Incl. *Nasoproculus*, Zang, 1905c.; ? *Ogyges*, Kaup, 1871; ? *Petrejoides*, Kuwert, 1896; *Triaenurgus*, Bates, 1886; ? *Truquius*, Bates, 1886.

Type, *Passalus mexicanus* Truqui, 1857, pp. 315-316.

Pseudacanthus bifidus (Zang).

Fig. IV, 13, p. 24.

Nasoproculus bifidus, Zang, 1905c, p. 232.

Six specimens from Mexico. Length 37-41 mm.

The antennal lamellae are long, being equal to three or four of the immediately preceding joints. The anterior margin of the labrum is deeply cleft; the sides of the labrum are straight and parallel. The clypeus is strongly arched on either side of a still stronger median concavity. The central tubercle resembles that of the genus *Oileus* in general form. There are no frontal tubercles or ridges. The parietal ridges are obsolete. The pronotum is unpunctured; its median groove is very strong, but does not quite reach the anterior margin. The scutellum is strongly punctured on either side of the middle line. The mesothoracic episterna are punctured above and near the anterior margin only; they are glossy, except for a matt oval patch behind the lower margin and a matt streak in the posterior angle. The mesosternum is glossy except in the scars, which are matt; it is unpunctured. The metasternum is hairless, and is unpunctured except in the posterior intermediate areas; the lateral areas are linear and smooth. The abdominal sterna are smooth. The grooves on the elytra are finely punctured laterally.

Pseudacanthus solidus (Arrow).

Fig. IV, 12, p. 24.

Triaenurgus solidus, Arrow, 1907, pp. 452-453.

Described from a (damaged) cotype, 39 mm. long, from Chuipache, Quezaltenango, Guatemala, lent by the British Museum.

The anterior margin of the labrum is lightly concave. The clypeus is straight, and bears a pair of small tubercles, each situated about half way from the middle line to the tubercle in which it terminates laterally. The parietal ridges, though somewhat small, are quite distinct. There are two or three punctures in or near the scars on each side of the pronotum. The matt areas of the mesothoracic episterna are even more restricted than in *P. bifidus*. The mesosternum is punctured and hairy laterally behind. The lateral areas of the metasternum are broad; both these areas, and the intermediate areas in front of and behind the usual group of coarse hairless punctures on the posterior intermediate areas, are covered with hair-bearing punctures. The abdominal sterna are smooth. In other respects this species resembles *P. bifidus*.

Pseudacanthus jalapensis, Bates.

Fig. IV, 14, p. 24.

Pseudacanthus jalapensis, Bates, 1886, p. 9, pl. i, figs. 10-10a.

One specimen from Oajaca, S. Mexico. Also a cotype from Jalapa lent by the British Museum. Length 22.0-23.5 mm.

P. jalapensis is very much smaller than either of the preceding species of the genus, and its antennal lamellae are much shorter in proportion than in those species. The clypeus is very lightly concave (practically straight) and has no tubercles except at its lateral extremities. A pair of small frontal tubercles is situated a little behind it, each about a third of the way from the end to the middle line. The frontal and parietal ridges are obsolete. The central tubercle is very large and resembles in form that of the two preceding species. The pronotum resembles that of *P. solidus*. The scutellum is strongly punctured near the middle line, especially behind. The mesothoracic episterna have one or two matt areas close to the lower margin, the rest of the surface being glossy; they are punctured above and along the anterior margin. The mesosternum is polished except along the lateral margins where it is dull. The metasternum has hair-bearing punctures only beside the middle coxae; the lateral areas are linear and somewhat rough; the general surface is glossy and unpunctured. The abdominal sterna are slightly roughened in the broad outermost parts of the scars only. The elytra are somewhat coarsely punctured in the grooves.

Genus **PROCULEJUS**, Kaup 1868b, p. 13.

Incl. ? *Eriopterus*, Kuwert, 1896; ? *Prosoclitus*, Bates, 1886.

Type, *Proculejus truquii*, Kaup, 1868b, pp. 16-17.

Proculejus pubicostis, Bates.

Fig. IV, 16, p. 24.

Proculejus pubicostis, Bates, 1886, p. 5, pl. i, figs. 4-4a.

Two specimens from Mexico, 30-31 mm. long.

The antennal lamellae are moderately long, being about equal to three of the immediately preceding joints in length. The labrum is parallel-sided, and is strongly concave in front. The clypeus is very lightly convex (practically straight); it bears an obscure tubercle at either end, and just behind and on the inner side of these tubercles is a pair of small frontal tubercles, which the obsolete frontal ridges do not clearly reach. The central tubercle is very large, it is massive and rounded at the base, but the long forwardly directed apex is somewhat slender. The parietal ridges are obsolete. The pronotum bears only a few fine hair-bearing punctures below the scars; the strongly impressed median groove scarcely reaches the anterior margin. The scutellum is strongly punctured on either side of the middle line, especially behind. The mesothoracic episterna are punctured above and in front; they are glossy except for an extensive matt band, which extends downwards from a little above the posterior angle of each towards the ventral angle. The mesosternum is polished except in the scars, which are deep and narrow. The metasternum resembles that of *Pseudacanthus jalapensis*. The abdominal sterna are smooth. The elytra are somewhat coarsely punctured above, very coarsely punctured at the sides; the last three ribs above the margin are finely punctured and hairy.

Proculejus sartori, Kaup.

Fig. IV, 15, p. 24.

Proculejus Sartorii, Kaup, 1868b, p. 17.

One specimen without locality record. Length 12.5 mm.

The labrum is concave in front, but not so strongly as in *P. pubicostis*. The clypeus is straight or lightly concave, and is united with the well developed frontal tubercles a little distance from each end. The frontal tubercles are united by well developed frontal ridges to the central tubercle, which is situated a little in front of the middle of the head; this tubercle is small and upwardly directed, and has no free apex. The scutellum is sparsely and somewhat finely punctured, especially in front. The mesothoracic episterna are punctured except in the posterior angles, and are glossy except for an oval patch behind the lower margin. In all other respects this species resembles the last, except that the mesosternal scars are shallower and that the elytral grooves are if anything even more coarsely punctured.

Proculejus truquii, Kaup.*Proculejus Truquii*, Kaup, 1868b, pp. 16-17.

One specimen from Mexico, 31 mm. long.

Proculejus truquii is much broader in proportion to its length than is either of the two preceding members of the genus. The head is ornamented much as in *P. sartori*, but the frontal area is somewhat narrower and the central tubercle is situated more in the middle. The pronotum resembles that of the two preceding species. The scutellum bears a few obscure punctures. The grooves of the elytra are very much broader and more coarsely punctured than in either of the preceding species, being about as wide as the ribs at the sides, and about half as wide above, the punctures in each groove being much broader than the spaces between them. In all other respects *P. truquii* resembles *P. sartori*.

Subfamily *PROCULINAE*.

Almost all members of this subfamily have the clypeus exposed as in the Pseudacanthinae; but it is fused with the frons instead of separated from it by a distinct suture. Faint traces of this suture, as of the outer tubercles, may perhaps be recognized in the genus *Arrox*, which is probably the most primitive genus of the family. From this genus the extensive genus *Veturius* may easily be derived; and this appears to have given rise to two divergent lines of descent, culminating respectively in the flightless genera *Platyverres* and *Proculus*. The former, in which the clypeus is completely hidden, is connected to *Veturius* through the genus *Verres*, in which all stages of the disappearance of the clypeus may be traced (compare fig. v, 11-15, p. 34). The latter, in which the specialized features associated with flightless species¹ reach their highest development, has the clypeus exposed, and is connected to *Veturius* by the genus *Publius*, a genus which only differs from species of *Veturius* with the two lowest terminal teeth fused by its fused elytra and reduced wings.

¹ See above pp. 4-5.

The genus *Procululus*, Zang (1905a, pp. 225-227, type, *P. inca*) is probably allied to *Publius* and *Proculus*, though in no other genus of Proculinae are the lateral areas of the metasternum known to be hairless—a character suggesting possible affinities with *Proculejoides*, in the subfamily Passalinae. It resembles *Publius* in having normal antennae, and *Proculus* in having egg-shaped elytra. The mandibles appear to resemble those of the last named genus.

The genera of Proculinae known to me may be defined thus:—

- | | | | |
|---|---|---|-----------------------------|
| 1 | { | The elytra separate, their vertical anterior part lightly concave | 2. |
| | | The elytra united along the middle line, their vertical anterior part more or less distinctly convex | 4. |
| 2 | { | The anterior lower tooth of the left mandible bidentate as seen from above; the clypeus always exposed and more or less horizontal; the anterior margin of the pronotum usually biconcave | 3. |
| | | The anterior lower tooth of the left mandible tridentate as seen from above; the clypeus steeper, or hidden and rudimentary; the anterior margin of the pronotum straight, or lightly biconvex | <i>Verres</i> , p. 40. |
| 3 | { | Rudimentary outer tubercles present; the anterior margin of the pronotum straight | <i>Arrox</i> , p. 33. |
| | | The outer tubercles absent; the anterior margin of the pronotum more or less sinuous or with a strongly sinuous marginal groove | <i>Veturius</i> , p. 35. |
| 4 | { | The clypeus entirely hidden; the mandibles tridentate distally | <i>Platyverres</i> , p. 41. |
| | | The clypeus broadly exposed; the mandibles usually bidentate distally | 5. |
| 5 | { | The lamellae of the antennae of moderate length; the anterior lower tooth of the left mandible broader than that of the right; the sides of the elytra approximately straight and parallel; the metasternum with distinct lateral areas .. | <i>Publius</i> , p. 42. |
| | | The lamellae of the antennae abnormally long and slender, the three together being narrower than any one of them is long; the mandibles symmetrical; the sides of the elytra strongly rounded; the metasternum without distinct lateral areas | <i>Proculus</i> , p. 42. |

Genus **ARROX**, Zang, 1905b, p. 155.

=*Sertorius*, Kaup, 1871, preoccupied.

Type, *Sertorius agassizi*, Kaup, 1871, p. 114.

Arrox agassizi (Kaup).

Fig. V, 1.

Sertorius Agassizi, Kaup, 1871, p. 114.

One specimen from Nicaragua, 30 mm. long. Both mandibles have three well developed terminal teeth; the anterior lower tooth of the right side is more or less columnar, that of the left is broadly bidentate as seen from above, but the anterior denticle is itself divided into two horizontally. The upper surface of the head though glossy is irregular, not smooth

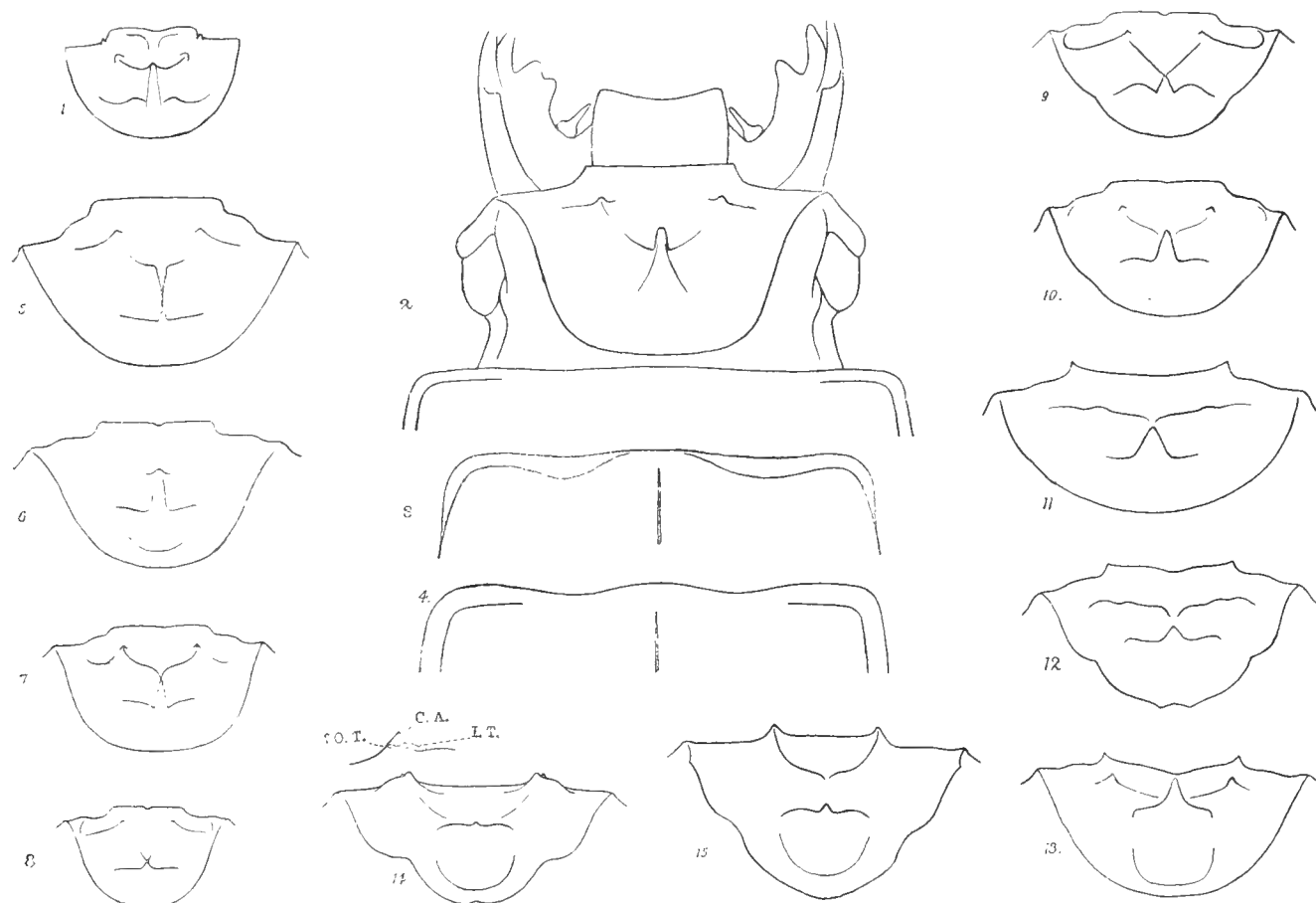


FIG. V.

Proculinae; specific characters in the head and prothorax $\times 4$.

C.A., clypeus angles; I.T., inner tubercles; O.T., outer tubercles.

- | | |
|---|---|
| 1. <i>Arrox agassizi</i> (Kaup). | 9. <i>Veturius boliviae</i> , Gravely. |
| 2. <i>Publius crassus</i> (Smith). | 10. <i>Veturius heydeni</i> , Kaup. |
| 3. <i>Veturius sinuatosulcatus</i> , Gravely. | 11. <i>Verres furcillabris</i> (Eschscholtz). |
| 4. <i>Veturius spinifer</i> , Gravely. | 12. <i>Verres sternipunctatus</i> , Kuwert. |
| 5. <i>Veturius sinuatosulcatus</i> Gravely. | 13. <i>Verres cavicollis</i> , Bates. |
| 6. <i>Veturius unicornis</i> , Gravely. | 14. <i>Verres corticola</i> (Truqui). |
| 7. <i>Veturius criniceps</i> , Kuwert. | 15. <i>Platyverres intermedius</i> (Kaup). |
| 8. <i>Veturius assimilis</i> (Weber). | |

as in species of the allied genera *Veturius* and *Verres*; and the clypeus is somewhat convex above. On either side of the clypeus is a rudimentary outer tubercle, but there is no ridge between these tubercles and the larger inner tubercles. The pronotum has a very few coarse punctures only in the slightly enlarged anterior extremities of the narrow marginal groove; its median groove scarcely reaches the anterior margin. The scutellum is thickly punctured on either side of a smooth middle line. The mesothoracic episterna are glossy and closely covered with strong coarse punctures above, matt and more faintly and sparsely

punctured and hairy below. The mesosternum is dull, unpunctured and hairless all over. The metasternum is punctured and hairy in the lateral and anterior intermediate areas only; the lateral areas are slightly broadened behind. The abdominal sterna are smooth and glossy, except the first pair of scars which are somewhat rough. The elytra are sparsely hairy between the shoulders; their grooves are somewhat strongly punctured. The middle tibiae each have a small spine before the end.

Genus **VETURIUS**, Kaup, 1871, p. 110.

Incl. *Pleurostylus*, Kaup, 1871 (see Arrow, 1907, pp. 449-450).

Type, *Passalus heydeni*, Kaup, 1868b, p. 27.

Veturius sinuatosulcatus, n. sp.

Fig. V, 3 & 5.

One specimen from Chaco, 40 mm. long.

The labrum is lightly concave in front, lightly convex at the sides. The mandibles (which are somewhat worn) appear to have been very like those of *Arrox agassizi*, but the two lowest terminal teeth have been fused, probably at the base only, and somewhat widely separated from the uppermost terminal tooth, especially on the left side. The head is smooth, with a strongly elevated central tubercle flanked by straight and somewhat forwardly directed parietal ridges. The central tubercle unites in front with a slender, finely pointed, V-shaped ridge or pair of ridges from which the obsolete frontal ridges arise at an obtuse angle to each other. The inner tubercles are well developed, but the frontal ridges do not reach them.

The sides of the pronotum are strongly concave, but are overhung by the strongly convex upper borders of the marginal grooves. The anterior margin is practically straight, but is bordered by a strongly sinuous marginal groove which, though much narrowed near the middle line, is scarcely broken. The pronotum is highly convex behind the median curve of this groove, which is enlarged on either side of the convexity. At the sides the groove is broad behind as well as in front, not narrow behind as in *V. sinuatocollis*, Kuwert. The median groove is deeply impressed and practically complete.

The scutellum is coarsely punctured in the anterior angles and on either side of all but the extreme posterior part of the middle line, bands meeting in the posterior angle to form an ↓-shaped figure being left unpunctured. The mesothoracic episterna are glossy and punctured above and along the anterior margin, matt and unpunctured behind. The mesosternum bears matt bands in the middle line and along the sides, meeting in a broad matt area in the anterior angle to form an ↑-shaped figure. Between these bands it is glossy. It is unpunctured and hairless throughout. The metasternum is punctured and hairy only in the anterior parts of the anterior intermediate areas and in the lateral areas; the lateral areas are moderately broad behind. The abdominal sterna are glossy. The grooves of the elytra are distinctly punctured, especially laterally; the shoulders are without hair. There is a strong spine a little beyond the middle of the middle and hind tibiae.

Veturius spinifer, n. sp.

Fig. V, 4, p. 34.

? *Veturius sinuatus*, Kuwert, 1898, p. 172 (*nec* Eschscholtz).

One specimen from Columbia ; two from Venezuela ; and three from Santa Catherina, S. E. Brazil. I have selected one of the Brazilian specimens as the type of the species. Length 42-45 mm.

Veturius spinifer agrees closely with Kuwert's description of *V. sinuatus*, but lacks the hairy shoulders of Eschscholtz's species. It is closely allied to *V. sinuatosulcatus* but differs in having more distinct frontal ridges, which proceed almost direct from the central to the inner tubercles at about a right angle to one another ; in having a normal pronotum with practically straight sides, sinuous anterior margin, marginal groove broadly incomplete and not enlarged in front, and no anterior median convexity ; in having the scutellum somewhat less regularly punctured ; and in having the mesosternum more or less matt all over. There are (? always) some hair-bearing punctures in the anterior angle of the mesosternum. The anterior intermediate areas of the metasternum are almost covered with hair-bearing punctures. The two lowest terminal teeth are smaller than the upper one and are fused at the base, but free distally.

Veturius platyrhinus (Hope).*Passalus platyrhinus*, Hope, 1845, p. 28.*Veturius platyrhinus*, Kaup, 1871, pp. 111-112.

Three specimens from Chiriqui, Panama, and one from Brazil. Length 48 mm.

This species differs from the last only in its larger size, and in the absence of spines from the middle and hind tibiae.

Veturius unicornis, n. sp.

Fig. V, 6, p. 34.

Two specimens from the Peruvian Amazon and one from the Upper Amazon. Length 34-37 mm.

The two lowest terminal teeth of both mandibles are completely fused. The inner tubercles and frontal ridges, as well as the outer tubercles, are entirely absent ; the central tubercle is distinct, but is less strongly elevated than in the three preceding species. The anterior margin of the pronotum is almost straight, and the marginal groove is narrow throughout. The scutellum is almost or quite unpunctured. The mesosternum is glossy except for a narrow band along each side and across the middle behind the anterior angle. The hairy portions of the anterior intermediate areas of the metasternum are very restricted. The grooves of the elytra are somewhat more distinctly punctured than in any of the three preceding species. In other respects this species resembles *V. spinifer*.

Veturius simillimus, Kuwert.*Veturius simillimus*, Kuwert, 1898, p. 167.

Eight specimens from Bahia, Brazil, 35-40 mm. long.

The mandibles resemble those of *V. unicornis*. The head resembles that of *V. spinifer*, or may be somewhat more slender, in which case the frontal ridges meet in a more acute

angle. A well-marked tubercle is sometimes present between the frontal tubercles. The scutellum is strongly punctured, except over a more or less well developed posterior median band and in the lateral angles. The whole of the mesothoracic episterna are punctured; in the matt areas the punctures bear hairs, but not elsewhere. The mesosternum bears a pair of glossy patches in an \wedge -shaped matt figure as in *V. sinuatosulcatus*; these patches bear a number of hair-bearing punctures, which become thicker on the matt surface anterior and lateral to them, but the median matt band is hairless and unpunctured. The metasternum is almost as extensively smooth as in *V. unicornis*. In all other respects *V. simillimus* resembles *V. spinifer*.

Veturius cephalotus (Saint-Fargeau and Serville).

Passalus cephalotus, Saint-Fargeau and Serville, 1825, p. 20 (*nec* Kuwert).

One specimen from Cayenne, one from Surinam, and five from the Peruvian Amazon. Length 35-40 mm.

Veturius cephalotus was first described from Cayenne, and our specimen from that locality bears a label showing that it was identified by Kaup. The species in our collection which most closely resembles Kuwert's *V. cephalotus* appears to me to be *V. sinuatus*, and one of these has been determined as *V. cephalotus* by Kaup, who regarded the two as identical. Kuwert's *V. sinuatus* is probably the species described above as *V. spinifer* although this lacks the hairy shoulders of the true *sinuatus* of Eschscholtz.

V. cephalotus differs from *V. simillimus* chiefly in the absence of the spines above the ends of the middle and hind tibiae, and in the uniformly punctured and hairy anterior intermediate areas of the metasternum. In addition, the two lowest terminal teeth are usually distinct at the apex on the right mandible and sometimes also on the left; the marginal grooves of the pronotum are inclined to be narrower in the anterior angles and more strongly punctured behind them; and the median matt band of the mesosternum is inclined to be broader, and the hair-bearing punctures to be more definitely concentrated into marginal bands.

Veturius sinuatus (Eschscholtz).

Passalus sinuatus, Eschscholtz, 1829, pp. 25-26.

?*Veturius cephalotus* (*nec sinuatus*), Kuwert 1898, p. 168.

Seven specimens from Brazil, including one from Rio Grande do Sul, one from Bahia, and two from Blumenau. Length 37-44 mm.

V. sinuatus is closely allied to *V. cephalotus*, but the two lowest terminal teeth, though fused at the base, are distinct distally on both mandibles; the frontal ridges are often obsolete; the matt posterior angles of the mesothoracic episterna are hairless and unpunctured; the metasternum resembles that of *V. simillimus*; and the elytra have a tuft of hair on the shoulders.

Veturius criniceps, Kuwert

Fig. V, 7, p. 34.

Veturius criniceps, Kuwert, 1898, p. 170.

Two specimens from Chiriqui, Panama, 32 mm. long.

The head differs from that of *V. simillimus* in having the central tubercle less elevated and set further forward, with the result that the frontal ridges meet in a very obtuse angle.

The mesosternum bears matt bands arranged as in *V. sinuatosulcatus*, but has in addition a band of hair-bearing punctures on either side of the whole length of the middle-line. The anterior lateral and intermediate areas of the metasternum are entirely covered with hair-bearing punctures. The elytra have a tuft of hair on the shoulders; they are less glossy than in other species, although the head and pronotum are normal in this respect. The middle but not the hind tibiae have a spine before the end. Otherwise *V. criniceps* resembles the much larger *V. simillimus* in structure.

Veturius assimilis (Weber).

Fig. V. 8. p. 34.

Passalus assimilis, Weber, 1801, p. 81.

One specimen from Rio de Janeiro, 26 mm. long.

The mandibles resemble those of *V. simillimus* and *V. criniceps*, but the head is much narrower than in these species, and the central tubercle is set much further back than in the latter, being if anything somewhat further from the inner tubercles than these are from each other. The frontal ridges are absent except close to the central tubercle, where they are directed straight towards the inner tubercles. The scutellum is strongly punctured on either side of a broad median band. The mesosternum resembles that of *V. simillimus*, but has fewer punctures. The grooves of the elytra are very strongly punctured. The middle and posterior tibiae have no spines before the end. In other respects this species resembles *V. simillimus*.

Veturius boliviae n. sp.

Fig. V, 9, p. 34.

Five specimens from Chaco, Bolivia, 31-34 mm. long.

Veturius boliviae is very like *V. cephalotus*, but is smaller, has three well developed terminal teeth on both mandibles, has very few punctures on the scutellum and the matt parts of the mesothoracic episterna, has hair-bearing punctures on either side of the middle line of the mesosternum as well as in front and at the sides and sometimes diffused over other parts, the middle line being matt narrowly or not at all, and has more or less impunctate grooves on the elytra.

Veturius heydeni, Kaup.

Fig. V, 10. p. 34.

Passalus Heydenii, Kaup. 1868b. p. 27.

? *Nec. Veturius heydeni*. Kuwert. 1898, p. 169.

One specimen from Mexico, 33 mm. long and very broad in proportion; determined by Kaup.

The frontal ridges and inner tubercles of this species are obsolete, and the short parietal ridges are dwarfed by the large central tubercle. In other respects the structure of this species resembles that of *V. boliviae*, except that the marginal grooves of the pronotum are narrower, that there is scarcely any hair near the middle line of the mesosternum and none between this and the marginal bands, which alone are matt, and that the elytra are more distinctly punctured.

The abovementioned species of *Veturius* may be recognized thus :—

- | | | | |
|----|---|--|------------------------------------|
| 1 | { | The mesosternum hairless and unpunctured except, as a rule, | |
| | | in the anterior angle | 2. |
| | { | The mesosternum with hair-bearing punctures behind or at the | |
| | | side, as well as in front | 5. |
| 2 | { | The anterior margin of the pronotum practically straight, only | |
| | | the anterior marginal groove sinuous; this groove almost | |
| | | complete across the middle line, where the pronotum is some- | |
| | | what strongly convex immediately behind it | <i>V. sinuatosulcatus</i> , p. 35. |
| | { | The pronotum normal, its anterior margin sinuous with widely | |
| | | broken marginal groove | 3. |
| 3 | { | The frontal ridges and inner tubercles present; the two lowest | |
| | | terminal teeth of both mandibles fused at base only | 4. |
| | { | The frontal ridges and inner tubercles absent; the two lowest | |
| | | terminal teeth of both mandibles completely fused | <i>V. unicornis</i> , p. 36. |
| 4 | { | The middle tibiae with spines above their ends | <i>V. spinifer</i> , p. 36. |
| | | The middle tibiae without spines above their ends | <i>V. platyrhinus</i> , p. 36. |
| 5 | { | The two lowest terminal teeth of both mandibles completely | |
| | | fused (spines present above the ends of the middle tibiae; the | |
| | | elytra hairless at the shoulders) | <i>V. simillimus</i> , p. 36. |
| | { | The two lowest terminal teeth fused at base only, in unworn | |
| | | specimens, on the right and usually also on the left mandible | 6. |
| 6 | { | The two lowest terminal teeth of the left mandible completely | |
| | | fused (no spines above the ends of the middle tibiae; the | |
| | | elytra hairless at the shoulders) | <i>V. cephalotus</i> , p. 37. |
| | { | The two lowest terminal teeth distinct at apex in unworn speci- | |
| | | mens on both mandibles. | 7. |
| 7 | { | The elytra with a tuft of hair on each shoulder | 8. |
| | | The elytra without any such tufts, (the middle tibiae without | |
| | | spines above the end) | 9. |
| 8 | { | The central tubercle normally situated, at least as far from the | |
| | | inner tubercles as these are from one another; the elytra | |
| | | normal; the middle tibiae without spines above the end | <i>V. sinuatus</i> , p. 37. |
| | { | The central tubercle set unusually far forwards, being nearer to | |
| | | the inner tubercles than they are to each other; the elytra | |
| | | less glossy than the head and thorax; the middle tibiae with | |
| | | spines above the end | <i>V. criniceps</i> , p. 37. |
| 9 | { | The central tubercle situated at least as far from the inner | |
| | | tubercles as these are from one another; the obsolete frontal | |
| | | ridges meeting in an acute angle | <i>V. assimilis</i> , p. 38. |
| | { | The central tubercle situated nearer to the inner tubercles than | |
| | | these are to each other; the frontal ridges meeting in an | |
| | | obtuse angle | 10. |
| 10 | { | The central tubercle normal, not free at apex; the frontal | |
| | | ridges moderately distinct | <i>V. boliviae</i> , p. 38. |
| | | The central tubercle slender, with free apex; the frontal ridges | |
| | | obsolete | <i>V. heydeni</i> , p. 38. |

Genus **VERRES**, Kaup, 1871, p. 114.

Type, *Passalus corticola*, Truqui, 1857, p. 310.

Verres furcilabris (Eschscholtz).

Fig. V, 11, p. 34.

Passalus furcilabris, Eschscholtz, 1829, p. 25.

Three specimens, of which two are from Para, Brazil. Length 40-44 mm.

The anterior margin of the labrum is very deeply incised. The mandibles each have three well developed terminal teeth. The central tubercle is massive, the inner tubercles and parietal ridges are obsolete. The median groove of the pronotum is practically complete. The marginal grooves are abruptly terminated and deeply impressed near the anterior angles. The scutellum is more or less densely punctured, except in the middle line and the anterior angles. The mesothoracic episterna are glossy and densely punctured, except in the posterior angles, which are extensively matt. The mesosternum is unpunctured and hairless (except in the anterior angle); it may be wholly matt or partially glossy. The metasternum is covered with hair-bearing punctures only in the anterior parts of the anterior intermediate areas and in the lateral areas, but there are some larger hairless punctures near the posterior margin. The abdominal sterna are smooth. The elytra are hairless; their grooves are strongly punctured, especially laterally. The middle and hind tibiae are without spines before the end.

Verres sternipunctatus, Kuwert.

Fig. V, 12, p. 34

Verres sternipunctus, Kuwert, 1898, p. 174.

Three specimens from Nicaragua, 33-38 mm. long.

I am doubtful whether this species is really distinct from *V. hageni*, Kaup; if not, the name *hageni* must stand.

The labrum is less deeply incised than in the preceding species, and the parietal ridges are distinct. The scutellum may be entirely covered with punctures. The mesosternum is entirely matt, with a few hair-bearing punctures on either side of the middle line and along the outer margins. The anterior intermediate areas of the metasternum are entirely covered with hair-bearing punctures. The grooves of the elytra are less strongly punctured than in the preceding species, which this one resembles in characters not mentioned.

Verres cavicollis, Bates.

Fig. V, 13, p. 34.

Verres cavicollis, Bates, 1886, p. 24, pl. i, figs. 20-20a, nec. Kuwert (see Arrow, 1907, p. 455).

One specimen from Guatemala, 37 mm. long.

The labrum is deeply incised, as in *V. furcilabris*, and is very strongly depressed behind the incision. The mandibles resemble those of other members of the genus. The inner tubercles are well developed, and the part of the head in front of them is short and almost vertical. The central tubercle has a slender free apex, and the parietal ridges, though small, are complete. The median groove of the pronotum does not nearly reach the anterior-

margin. The marginal grooves are rudimentary, except in the anterior angles where they form a pair of large circular pits punctured on the inner side. The scutellum is almost entirely covered with punctures. The mesothoracic episterna resemble those of other members of the genus. The mesosternum is matt and is entirely covered with hair-bearing punctures except near the middle line behind. The metasternum is covered with hair-bearing punctures, except the central area and the inner parts of the posterior intermediate areas, which bear a number of hairless punctures behind. The abdominal sterna are smooth. The elytra and legs resemble those of *V. sternipunctatus*.

Verres corticola, (Truqui).

Fig. V, 14, p. 34.

Passalus corticola, Truqui, 1857, p. 310.

Numerous specimens from Guatemala and one from Mexico. Length 31-36 mm.

The labrum is slightly concave in front. The mandibles resemble those of other members of the genus. The central tubercle is fused with the pair of short parietal ridges to form a massive protuberance, in front of which the more or less distinct frontal ridges extend towards the inner tubercles at a somewhat obtuse angle to one another. The inner tubercles are distinct as in *V. cavicollis*, but are situated on the anterior margin of the head with only the angles of the clypeus visible in front of, or rather below, them. The angles of the clypeus are somewhat more widely separated than the inner tubercles, and a pair of rudimentary outer tubercles may perhaps be recognized in a pair of more or less tumid areas connecting them. The addition to fig. v, 14, illustrates these tubercles and the clypeus angle on the left side, being drawn on a larger scale than the main figure, and from a more anterior position. The prothorax and mesothorax resemble those of *V. furcilabris*, except that the scutellum is more sparsely punctured. The metasternum and elytra resemble those of *V. sternipunctatus*. The abdominal sterna and legs resemble those of other members of the genus.

The above mentioned species of *Verres* may be recognized as follows:—

- | | | | |
|---|---|---|------------------------------------|
| 1 | { | The clypeus extensive, oblique; the inner tubercles obsolete | 2. |
| | | The clypeus smaller, almost vertical, or rudimentary; the inner tubercles distinct | 3. |
| 2 | { | The labrum very deeply cleft; the parietal ridges obsolete . | <i>V. furcilabris</i> , p. 40. |
| | | The labrum less deeply cleft; the parietal ridges short but distinct | <i>V. sternipunctatus</i> , p. 40. |
| 3 | { | The labrum very deeply cleft; the clypeus distinct; the apex of the central tubercle free; a pair of large circular pits in the anterior angles of the pronotum | <i>V. cavicollis</i> , p. 40. |
| | | The labrum not deeply cleft; the clypeus hidden and rudimentary; the apex of the central tubercle not free; the pronotum normal | <i>V. corticola</i> , p. 41. |

Genus **PLATYVERRES**, Bates, 1886, p. 9.

Type, *Verres intermedius*, Kaup, 1871, p. 115.

Platyverres intermedius (Kaup).

Fig. V, 15, p. 34.

Verres intermedius, Kaup, 1871, p. 115.

One specimen (with worn mandibles) from Omilteme, Guerrero, lent by the British Museum. Length 42.5 mm.

Platyverres intermedius is closely allied to *Verres corticola*. The labrum is, however, somewhat more deeply excavate; the clypeus is entirely hidden even at the angles; the frontal ridges are broadly arched and are more or less confluent half way between the central tubercle and the anterior margin of the head; the anterior ends of the marginal grooves of the prothorax are less deeply impressed; the lateral areas of the metasternum, though punctured and hairy, are narrow throughout; the elytra are united and are more coarsely punctured in the grooves.

Genus **PUBLIUS**, Kaup, 1871, p. 70.? Incl. *Procululus*, Zang, 1905a.Type, *Passalus crassus*, Smith, 1852, p. 14.**Publius crassus** (Smith).

Fig. V, 2, p. 34.

Passalus crassus, Smith, 1852, p. 14.

One specimen from Bogota, Columbia, 43.5 mm. long.

The antennal lamellae are short, being equal to about two of the immediately preceding joints in length. The labrum is broader behind than in front; its anterior margin is lightly concave, its sides are lightly convex. Both mandibles are bidentate distally; the left one has a broad bifid tooth between these teeth and the moveable tooth; the right one has a simple conical tooth in this position. The frontal ridges are obsolete; the frontal tubercles are broad and short and somewhat rounded; the central tubercle has a slender but not very long free apex, which is less depressed than that of *Proculejus pubicostis*. The pronotum is unpunctured, and its scars are indistinct; its median groove does not nearly reach the anterior margin. The scutellum bears a few large punctures near the middle line in front. The mesothoracic episterna are extensively matt and unpunctured in the posterior angles, being glossy and punctured elsewhere. The mesosternum is glossy, except in the scars, which become very large and almost meet in the middle line in front. The metasternum is glossy, unpunctured and hairless except beside the middle coxae and in the linear lateral areas. The abdominal sterna are smooth. The grooves on the elytra are very faintly punctured.

Genus **PROCULUS**, Kaup, 1868b, p. 8.Incl. *Cyphoproculus*, Kuwert, 1896.Type, *Passalus goryi*, Melly, 1833, pl. lvi.

Proculus goryi (Melly).

Passalus goryi, Melly, 1833, pl. lvi.

Two specimens from Vera Paz, Guatemala, 67-72 mm. in length.

Proculus goryi may readily be distinguished from the other two species before me by the obsolete upper tooth of the mandibles, normally flattened mentum, and glossy elytra.

Proculus opacipennis (Thomson).

Passalus opacipennis, Thomson, 1857, pp. 420-421, pl. xxi, fig. 4.

Three specimens from Ecuador and two from Guatemala, 51-56 mm. in length.

Proculus opacipennis has a long and slightly curved upper tooth on each mandible, a normally flattened mentum, and matt elytra.

Proculus mniszechi, Kaup, 1868.

Proculus mniszechi, Kaup, 1868b, pp. 11-13.

Eight specimens from Guatemala (mostly from Vera Paz), one from Ecuador, and one from San Pedro Sula, Honduras. They vary from 53-69 mm. in length.

Proculus mniszechi has an acute and well developed upper tooth on each mandible, glossy elytra, and a mentum with the inner margin of the forwardly directed lateral processes turned almost at right angles to the rest of the plate in a ventral direction to form a pair of smoothly rounded lobes.

Subfamily *PASSALINAE*.

The subfamily Passalinae as represented in the collection before me includes five clearly defined genera, and a large assemblage of species separated from one another by various combinations and modifications of characters so graded as thoroughly to obscure their true relationships one to another.

In the first three genera the clypeus is always exposed and the antennae always have three lamellae. The first of them, *Chondrocephalus*, only differs from the primitive Pseudacanthine genus *Popilius* in having no suture between the clypeus and the frons and no hair on the lateral areas of the metasternum. *C. quinquecornutus* is to some extent transitional between the two genera, having definite traces of the suture; but as these are not very distinct and as the lateral areas of the metasternum are hairless it seems to me to make, on the whole, a better *Chondrocephalus* than *Popilius*.

The second genus, *Vindex*, contains one species, *V. agnoscendus*, in which the clypeo-frontal suture is distinct throughout as in the Pseudacanthinae; and but for its flattened form and separate elytra with hairless sides this species might have been held to indicate the relationship of its genus to *Proculejus* instead of to *Chondrocephalus*; for *Vindex* possesses the main peculiarities of the dentition characteristic of *Proculejus* (see above, p. 10).

One species of *Vindex*, described below for the first time, has the elytra united as they are in the next genus *Proculejoides*. But whereas this species retains the flattened form characteristic of other species of *Vindex*, *Proculejoides* has assumed the more massive form ordinarily assumed by flightless species of all groups.

The fourth genus, *Paxillus*, is distinguished from all others by having more than three well developed lamellae on each antenna. In some species the clypeus is exposed and in others it is hidden; but all are closely related to one another and as they are not very numerous all the genera which have been established for them may conveniently be united into one. It is probable that a considerable proportion of the species that have been described are invalid (see Arrow, 1907, p. 443).

The remaining species, though undoubtedly numerous, probably require proportionally still more drastic reduction of their numbers. It seems to be impossible to separate them into groups having the same value as the genera mentioned above. Consequently I propose to regard almost all of them as constituting a single large and plastic genus *Passalus*.

The only exception is the genus *Ptichopus*, the last and in some respects the most highly specialized genus of the subfamily. It may readily be recognized from all others by the remarkable structure of its mandibles.

The genera of Passalinae known to me may be separated thus:—

1	{	The clypeus clearly exposed; the antennae with not more than three well developed lamellae	2.
		The clypeus hidden ¹ ; or, the antennae with more than three well developed lamellae	4.
2	{	The dentition normal; the clypeus more or less horizontal	<i>Chondrocephalus</i> , p. 44.
		The dentition reduced; the clypeus more or less vertical	3.
3	{	Much flattened insects with the inner and outer tubercles almost in a straight line on the upper part of the anterior margin of the head, and projecting forwards above the clypeus	<i>Vindex</i> , p. 46.
		Robust insects with the cephalic tubercles normally situated	<i>Proculejoides</i> , p. 47.
4	{	The antennae with more than three well developed lamellae; the clypeus exposed or hidden	<i>Paxillus</i> , p. 48.
		The antennae with not more than three well developed lamellae; the clypeus hidden ¹	5.
5	{	The dentition normal	<i>Passalus</i> , p. 51.
		The upper terminal tooth very large and acute, directed forwards; the middle one rudimentary or absent; the lowest one very small, directed inwards	<i>Ptichopus</i> , p. 68.

Genus **CHONDROCEPHALUS**, Kuwert, 1896, p. 221.

Type, *Popilius granulifrons*, Bates, 1886, p. 12, pl. i, figs. 13-13a.

Chondrocephalus quinquecornutus, n. sp.

Fig. VI, 1.

Two complete specimens from Guatemala and one dissected head. Length 17 mm.

The lamellae of the antennae are moderately long and slender. The anterior lower tooth of the left mandible is broad and more or less distinctly bidentate, that of the right

¹ Exposed to some extent in *Passalus guatemalensis*; see below, p. 57.

mandible slender and scarcely if at all bidentate. The anterior margin of the labrum is straight, the sides all lightly convex. The parietal ridges are somewhat short. The central tubercle is laterally compressed; its base extends forwards to the point at which the frontal ridges diverge towards the stout conical inner tubercles, from which tubercles they bend abruptly outwards to end in the similar outer tubercles—a character in which this species differs from *C. granulum*, Kuwert, to which it appears to be more nearly related than to any other species yet described. The transverse course of the ends of the frontal ridges, combined with the more irregular (though glossy) surface of the whole area in front of the inner and outer tubercles combine in some specimens to give this area an appearance of being definitely cut off from the rest of the head, as is the clypeus from the frons in the genus *Popilius*. The anterior margin of the clypeus is more or less distinctly notched.

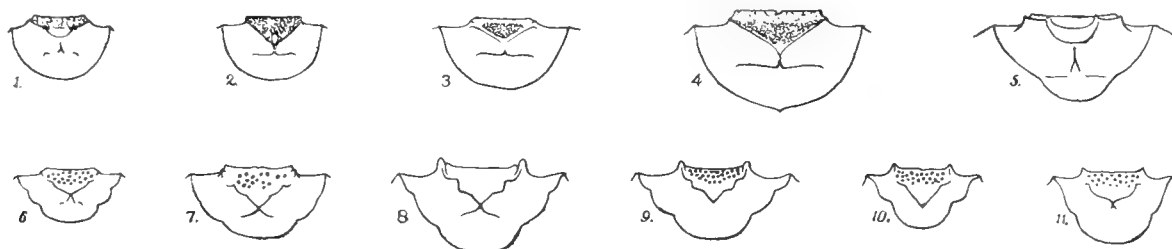


FIG. VI.

Passalinae (except *Passalus*); specific characters in the upper surface of the head $\times 4$.

- | | |
|---|--|
| 1. <i>Chondrocephalus quinquecornutus</i> , Gravelly. | 7. <i>Paxillus brasiliensis</i> (St. Farg. and Serv.). |
| 2. <i>Chondrocephalus cordiger</i> , Gravelly. | 8. <i>Paxillus pentaphyllus</i> (Beauvois). |
| 3. <i>Chondrocephalus purulensis</i> (Bates). | 9. <i>Paxillus leachii</i> , MacLeay. |
| 4. <i>Chondrocephalus granulifrons</i> (Bates). | 10. <i>Paxillus robustus</i> (Percheron). |
| 5. <i>Vindex synelytris</i> , Gravelly. | 11. <i>Paxillus crenatus</i> , MacLeay. |
| 6. <i>Paxillus camerani</i> (Rosmini). | |

The angles of the pronotum are rounded, the posterior more so than the anterior. The sides and marginal grooves of the pronotum are coarsely and irregularly punctured; there are no distinct scars. The scutellum bears a few punctures near the middle. The mesothoracic episterna are glossy throughout, and are coarsely but somewhat sparsely punctured except in the posterior angles, which are smooth. The mesosternum is smooth and glossy, except the lateral margins which are matt. The metasternum is hairless; its lateral areas are narrow and slightly roughened throughout; there are a few large punctures on the posterior borders of the intermediate areas. The abdominal sterna are glossy. All the grooves of the elytra are coarsely punctured. The middle and posterior tibiae are armed with about two spines each before the apex.

***Chondrocephalus cordiger*, n. sp.**

Fig. VI, 2.

One specimen from Guatemala, 18.3 mm. long.

The antennae, mandibles and labrum resemble those of *C. quinquecornutus*. The parietal ridges are somewhat longer than in that species. The frontal ridges extend straight from the anterior extension of the central tubercle to the small outer tubercles. Not far from the central tubercle they are united by a curved groove, immediately beyond which is a pair of almost obsolete inner tubercles. The somewhat heart-shaped area enclosed between this groove and the frontal ridges is smooth and glossy, like the surface of the

head without and behind the ridges ; in front of this groove and between the ridges it is matt.

The marginal grooves of the pronotum are more finely and evenly punctured than in *P. quinquecornutus*. The coarse punctures on the sides of the pronotum are less numerous than in that species, and a pair of punctured scars are evident ; there are a few coarse punctures on the dorsal surface as well as at the sides.

The scutellum is without punctures. The mesothoracic episterna, mesosternum and abdominal sterna resemble those of *P. quinquecornutus* ; the metasternum is more extensively punctured in the posterior intermediate areas. The punctures in the grooves of the elytra, and the spines on the middle and posterior tibiae, are not quite so pronounced as in that species.

Chondrocephalus purulensis (Bates).

Fig. VI, 3, p. 45.

Popilius purulensis, Bates, 1886, p. 13.

One specimen from Guatemala, 22·8 mm. long.

The anterior margin of the labrum is slightly concave, and the sides are slightly convergent behind. There are no inner tubercles. The frontal ridges, which are flattened above, are straight and meet in a more obtuse angle than in either of the preceding species ; they and the clypeus are glossy, the whole of the triangular area bounded by them being matt. In other respects the head resembles that of *C. cordiger*, as do also the antennae and mandibles.

The pronotum resembles that of *C. cordiger* in form, but the scars are more pronounced and there are no coarse punctures on the general surface, either at the sides or nearer the middle. The scutellum bears a group of punctures on either side of the middle line ; in other respects the mesothorax resembles that of the two preceding species. The metasternum bears a few punctures in the inner angles only of the posterior intermediate areas. The abdominal sterna, elytra and legs resemble those of *C. cordiger*.

Chondrocephalus granulifrons (Bates).

Fig. VI, 4, p. 45.

Popilius granulifrons, Bates, 1886, p. 12.

Numerous specimens from Guatemala, 26·2–32·2 mm. long.

C. granulifrons differs from *C. purulensis* in having the frontal ridges (which meet in a right angle) less flattened above, with the inner tubercles more or less imperfectly developed and sometimes united. The small area behind and between the inner tubercles is glossy, that between the inner and outer tubercles matt, and the clypeus more or less rough and glossy. The puncturing on the scutellum is variable. The spines on the middle and hind tibiae are stronger.

Genus **VINDEX**, Kaup, 1871, p. 78.

Type, *Passalus agnoscendus*, Percheron, 1841, p. 22, pl. lxxviii, fig. 2.

Vindex agnoscendus (Percheron).

Passalus agnoscendus, Percheron, 1841, p. 22, pl. lxxviii, fig. 2.

Seven specimens from Mexico, 20–22.4 mm. long.

This species may readily be recognized from either of the other two members of the genus known to me by its free elytra, with coarsely, but not transversely punctured lateral grooves. It is also characterized by the presence of a distinct trace of the lowest terminal tooth of the right mandible, and of a distinct clypeofrontal suture. The inner tubercles are situated upon this suture as in certain species of *Pseudacanthus* and *Proculejus*, and the suture is most readily seen between them, where it replaces the ridge found in this position in other species.

Vindex sculptilis, Bates.

Vindex sculptilis, Bates, 1886, p. 13.

Numerous specimens from Guatemala, 20.3–23.0 mm. long.

In this species there is no definite trace of the lowest terminal tooth on either mandible, and there is no clypeofrontal suture. The elytra are free, and the punctures in their lateral grooves are very large and transverse.

Vindex synelytris, n. sp.

Fig. VI, 5, p. 45.

Three specimens from Guatemala, 23.8–25.0 mm. long.

The head and mandibles resemble those of *V. sculptilis*. The elytra are united in the middle line, though their form is unmodified and the wings are well developed; the lateral grooves are coarsely but not transversely punctured; their dorsal grooves are more finely punctured than in either of the other two species.

Genus **PROCULEJOIDES**, Kuwert, 1896, p. 221.

Type, *Proculejus championi*, Bates, 1886, pp. 5-6, pl. i, figs. 5-5a.

Proculejoides championi (Bates).

Proculejus championi, Bates, 1886, pp. 5-6, pl. i, figs. 5-5a.

Numerous specimens from Guatemala, which show that the species is very variable in size (length 23.5–32.0 mm.), and that the ridges bounding the frontal area are variable, both as to form and distinctness.

The mandibles closely resemble those of *Proculejus*. The clypeus, though exposed, is bent downwards as in *Verres cavicollis* and is far from conspicuous, not even being prominent laterally as in that species. Both outer and inner tubercles are distinct, but the frontal ridges are obsolete in front of the latter. The prothorax resembles that of *Chondrocephalus granulifrons* except for its greater convexity. The scutellum is not distinctly punctured. The mesothoracic episterna and mesosternum resemble those of *C. granulifrons* except for a ventral matt patch on each of the former. The

metasternum is unpunctured and has smooth hairless narrow lateral areas. The abdominal sterna are glossy. The outermost grooves of the elytra are very indistinctly punctured; the dorsal grooves are unpunctured. The middle tibiae each bear two, and the posterior one, strong spine before the apex.

Genus **PAXILLUS**, MacLeay, 1819, p. 105.

Incl. *Paxilloides*, Kuwert, 1896; *Paxillosomus*, Kuwert, 1896; *Spasalus*, Kaup, 1868.

Type, *Paxillus leachii*, MacLeay, 1819, p. 106 (Paris edition, p. 20).

Paxillus camerani (Rosmini).

Fig. VI, 6, p. 45.

Paxillosomus camerani, Rosmini, 1902, pp. 4-5.

One specimen from the Upper Amazon; 16 mm. long.

The anterior margin of the labrum is straight; the sides are lightly convex. The last five joints of the antennae are lamellate, the middle lamella being distinctly the longest, though this scarcely exceeds the one immediately preceding it by as much as does the corresponding lamella of *P. pentaphyllus*. The mandibles each have three distinct terminal teeth, of which the middle one is perhaps slightly nearer to the one below it than to the one above it. The left anterior lower tooth is broader than the right and is probably bidentate when unworn as in other species. The central tubercle and parietal ridges are small. The frontal ridges extend from the central tubercle at a very obtuse angle to each other towards the outer tubercles, their course being slightly curved. The inner tubercles are distinct and are nearer to the outer than to the central tubercle. The outer tubercles, which are bluntly conical, are little larger than the inner; they do not overhang the angles of the clypeus, which project horizontally in front of them, terminating the lightly concave anterior margin of the clypeus. The area between the frontal ridges is punctured in front of the inner tubercles, and smooth behind them.

The pronotum is coarsely punctured laterally except (? always) in the neighbourhood of the scars. The sides and anterior margin of the pronotum are straight, with the angles between them slightly prominent. The posterior margin and angles are rounded; the latter are densely covered beneath with long yellowish hair. The marginal groove is fine; the median groove is almost complete. The posterior plate of the prosternum is broadly truncate behind, being little narrower behind than in front. There are a few indistinct scattered punctures on the scutellum. The mesothoracic episterna are glossy above, and matt, except beside the anterior margin, below; they are punctured except in the posterior angles. The mesosternum is glossy, with deep punctured scars. The lateral areas of the metasternum are narrow throughout, rugose, and very finely hairy; a row of punctures extends along the inner side of the posterior intermediate areas. The abdominal sterna are polished except in the scars, which are matt. The elytra are densely and somewhat extensively hairy at and below the shoulders; their lateral grooves are coarsely, their dorsal grooves more finely, punctured.

Paxillus brasiliensis (Saint-Fargeau and Serville).

Fig. VI, 7, p. 45.

Passalus brasiliensis, Saint-Fargeau and Serville, 1825, p. 21.*Paxilloides brasiliensis*, Kuwert, 1898, p. 181.

Three specimens from Bolivia, one from Bogota, one from Yucatan and two without locality labels. Length 18–21 mm.

I follow Kuwert with regard to this determination; the original description (quoted by Guérin, 1828, p. 90) being altogether inconclusive.

The anterior margin of the labrum is lightly concave as a rule. The ends of the five antennal lamellae form a straight line when furled, the middle lamella being scarcely if at all longer than the penultimate one. The anterior margin of the clypeus may be lightly concave, or may be lightly convex close to (but on either side of) the middle line, where in this case it is faintly notched. The frontal ridges arise at right angles to one another and are practically straight; the extent of the transverse anterior punctured area between them is variable. The posterior angles of the pronotum bear only a small patch of short hair beneath. The mesosternal scars may be smooth or rugulose, glossy or matt. The lateral areas of the metasternum are hairless. The strength of the puncturing of the dorsal grooves of the elytra is somewhat variable. The shoulders of the elytra are somewhat hairy, but are not densely covered with long pile as in the preceding species. In other respects the present species resembles the last.

Paxillus pentaphyllus (Beauvois).

Fig. VI, 8, p. 45.

Passalus pentaphyllus, Beauvois, 1805, p. 2, pl. i, fig. 2.

One specimen from Mosquito 26.3 mm. long.

The anterior margin of the labrum is somewhat more strongly convex than in the preceding species. The antennae resemble those of *P. camerani*, but the ends of their lamellae when furled form a somewhat more strongly curved line. The outer tubercles are long and slender, and are directed forwards above the angles of the clypeus which, however, are exposed beneath them. The area between the outer tubercles is glossy and unpunctured. In other respects this species resembles the preceding one, except that the posterior intermediate areas of the metasternum are more extensively and very coarsely punctured.

Paxillus leachii, MacLeay.

Fig. VI, 9, p. 45.

Paxillus leachii, MacLeay, 1819, p. 106 (Paris edition, p. 20).

Many specimens from Guatemala, Iquitas (Upper Amazon), Bahia, Rio de Janeiro, Para, Esperito-Santo (Brazil), Bolivia, Nicaragua, British Honduras, Mexico, and Montevideo. Length 16.0–21.5 mm.

This species differs from the last only in having the anterior margin of the labrum less strongly concave, in having the ends of the antennal lamellae in a straight line when the antennae are furled, in having coarse punctures between the outer tubercles of the head,

in having the lower side of the prothorax still less hairy, and in having the posterior intermediate areas of the metasternum more finely punctured.

Paxillus robustus (Percheron).

Fig. VI, 10, p. 45.

Passalus robustus, Percheron, 1835, pp. 35-36, pl. iii, fig. 1.

Several specimens from different localities in Brazil (Santa-Catherina, Bahia, Rio de Janeiro and Esperito-Santo). Length 15.2-18.0 mm.

This species and the next are less strongly flattened than any of the preceding members of the genus; they have the posterior plate of the prosternum strongly tapered behind and have the clypeus entirely hidden; the outer tubercles are variable in size, but are probably always somewhat long and slender in unworn specimens, and the frontal ridges are obsolete between them and the inner tubercles, though well developed between the inner tubercles and central tubercle. The anterior angles of the head are sometimes rather strongly produced and acute. The sides of the pronotum are more extensively, and the grooves of the elytra more coarsely punctured than in *P. leachii*, which this species resembles in other respects, except that the shoulders of the elytra are entirely hairless. The tibiae of the intermediate (and to a less extent the hind) legs often bear several strong spines on the outer side, especially in small specimens.

Paxillus crenatus, MacLeay.

Fig. VI, 11, p. 45.

Paxillus crenatus, MacLeay, 1819, p. 10; (Paris edition, p. 20).

Several specimens from the Upper Amazon, Guadaloupe, Surinam and Mosquito. Length 17.0-19.5 mm.

This species differs from the last only in having the frontal ridges broadly arcuate, instead of meeting abruptly, in having the anterior extremities of the marginal grooves of the pronotum broader and deeper, and in having the metasternum and elytra somewhat less strongly punctured.

The above mentioned species of *Paxillus* may be recognized from one another, as follows:—

- | | | | | |
|-----|---|----|----|---------------------------------|
| 1 { | Much flattened insects, with the clypeus more or less exposed | .. | .. | 2. |
| 1 { | More robust insects, with the clypeus entirely hidden | .. | .. | 5. |
| 2 { | The outer tubercles short and blunt, not directed forwards | | | |
| 2 { | above the clypeus | .. | .. | 3. |
| 2 { | The outer tubercles long and slender in unworn specimens, | | | |
| 2 { | directed forwards above the angles of the clypeus which | | | |
| 2 { | they tend to obscure | .. | .. | 4. |
| 3 { | The frontal ridges meeting in a strongly obtuse angle; the | | | |
| 3 { | posterior angles of the pronotum, and the shoulders of the | | | |
| 3 { | elytra, densely covered beneath with long yellowish hair | | | <i>P. camerani</i> , p. 48. |
| 3 { | The frontal ridges meeting in a right angle; the posterior angles | | | |
| 3 { | of the pronotum, and the shoulders of the elytra, less hairy | | | |
| 3 { | beneath | .. | .. | <i>P. brasiliensis</i> , p. 49. |

- 4 { The ends of the antennal lamellae in a strongly curved line
 when furled; the anterior margin of the head unpunctured *P. pentaphyllus*, p. 49.
 { The ends of the antennal lamellae in a straight line when furled;
 the anterior margin of the head coarsely punctured between
 the outer tubercles *P. leachii*, p. 49.
 5 { The frontal ridges straight, arising at right angles to each
 other *P. robustus*, p. 50.
 { The frontal ridges together forming a crescent *P. crenatus*, p. 50.

Genus **PASSALUS**, Fabricius, 1792, p. 240.

= *Neleus nec Passalus*, Kaup, etc. (see Zang, 1905c, pp. 224 and 226).

Incl. **Epiphanus*+*Eumelus*+*Lucilius*+*Mitrorhinus*¹+**Neleides*+**Ninus* (= *Scalmus*, Zang)
 + **Pertinax*+**Petrejus*+**Phoroneus* (= *Macrolobus*, Zang) + *Rhagonocerus*+**Rhodocanthopus*
 + *Stephanocephalus*¹ + **Vatinius* (= *Zosterothrix*, Zang), Kaup. Also **Aponeleides*+*Cassius*+*Epipertinax*+**Flavius* (= *Lasioperix*, Zang), + *Lophocephalus*+*Manlius*
 + *Microthorax* (= *Phaulothorax*, Zang) + **Morosophus*+**Neleuops* + *Ninoides* + *Oeneus*
 + *Parapertinax* + **Pertinacides* + *Phanocles* (= *Psilomus*, Zang) + **Phoronaecosomus* +
Polyacanthopus+**Ptychotrichus* (= *Epipleurothrix*, Zang) + *Severus*+*Synesius*+**Tetraracrus*+*Thryptocerus*
 (= *Alococerus*, Zang) + *Toxeutotaenius*+**Trichopleurus*+*Valerius*, Kuwert. Also **Epiphoroneus*, Arrow.

Type, *Lucanus interruptus*, Linnaeus, 1767, p. 560.²

It seems probable, and has been assumed in the above synonymy, that all genera belonging to Kuwert's subfamilies Rhodocanthopinae, Neleidinae, Pertinacinae, Pleurariinae (except *Pleurarius* which belongs to the Indo-Australian Series), Phoronaeinae, Petrejiniae, Vatiniinae and Neleinae should be included in this complex and heterogeneous genus; but I have been able to confirm this by reference to specimens only in the case of the genera marked with an asterisk (*). The genus *Prosoclitus*, Bates, has been omitted because I think, judging from Bates' description, which is all that Kuwert also had to go upon, that Bates was probably right in regarding the species for which he founded it as closely allied to the genus *Proculejus*.

One of Kaup's species of *Proculejus*, *P. quitensis*, was rightly removed by Kuwert to one of his subfamilies here included in the genus *Passalus*; but the genus *Prosoclitus*, in which he placed it, is probably allied to if not identical with *Proculejus*, not *Passalus*. *P. quitensis* differs from all other species of *Passalus* known to me in having the elytra united; but, if this character is to be regarded as in itself sufficient to warrant the separation of the species possessing it into special genera, new genera will be required for one of the four described species of *Vindex*, and for each of two species that otherwise fall into two widely separated divisions of the genus *Macrolinus*. This multiplication of small genera seems to me undesirable, although I have found it convenient to retain the already existing small flightless genera *Platyverres* and *Publius*, instead of uniting them

¹ See above, pp. 10-11.

² This is the reference usually given, but is not the earliest description. See below, p. 63, footnote.

with *Verres* and *Veturius* respectively, as would have been more consistent. *Proculejus quitensis* consequently becomes *Passalus quitensis*.

In spite of the complex manner in which various specific characters are intermingled, the species of *Passalus* can be arranged in a series leading up from forms with the margin of the head between the outer tubercles straight or faintly notched in the middle line, the inner and outer tubercles usually more or less widely separated, and the lateral areas of the metasternum usually narrow, smooth and hairless, to forms with the margin of the head abruptly emarginate in the middle line, the inner and outer tubercles in contact with one another, together forming an oblique edge, and the lateral areas of the metasternum broad, punctured and hairy. The following descriptions have been placed in this order.

***Passalus nanus* (Kuwert).**

Rhodocanthopus nanus, Kuwert, 1898, p. 139.

One or two specimens from each of the following localities—Guatemala, Ecuador, and the Cauca Valley in Columbia. Length 15.3–17.7 mm.

This species is very like *Paxillus robustus*, but its antennae have only three well developed lamellae, its frontal ridges are apt to be more denticulate (especially in Columbian specimens), its eyes are smaller and less prominent, its pronotum and elytra are much more coarsely punctured, the punctures in the lateral grooves of the elytra being more or less distinctly transverse, and its intermediate and hind tibiae are still more strongly spined. The epipleura are unpunctured and hairless as in *Paxillus robustus*.

***Passalus rugosus*, n. sp.**

Fig. VII, 1.

Three specimens from the Cauca Valley, Columbia. Length 21.0–21.8 mm.

The central tubercle is relatively nearer to the anterior margin of the head than in *P. nanus*, the frontal ridges consequently diverging in a more obtuse angle. The sides of the pronotum are very coarsely punctured, but there are no coarse punctures nearer the middle as in *C. nanus*, nor are there any on the central area of the metasternum as in that species. The grooves of the elytra are even more strongly punctured than in *C. nanus*, the punctures in the lateral grooves being distinctly transverse. The epipleura are punctured and hairy. In other respects this species resembles *P. nanus*.

***Passalus punctato-striatus*, Percheron.**

Fig. VII, 2.

Passalus punctato striatus, Percheron, 1835, pp. 78-79, pl. vi, fig. 1.

A large number of specimens from Guatemala and Mexico, some of the latter being from Oaxaca; a few from San Salvador, Honduras (San Pedro Sula), Nicaragua, Columbia and Surinam. Length 20.3–28.3 mm., relative breadth extremely variable; the distance between the inner and outer tubercles, and other characters, also variable to some extent.

This species differs from the last only in having the frontal area slightly larger, the pronotum and the grooves of the elytra less coarsely punctured, the epipleura unpunctured

and hairless, and the middle and hind tibiae usually unspined or nearly so.¹ The difference is most marked as regards the punctures in the dorsal grooves of the elytra, those in the pair of grooves nearest the suture being almost impunctate in most specimens of the present species.

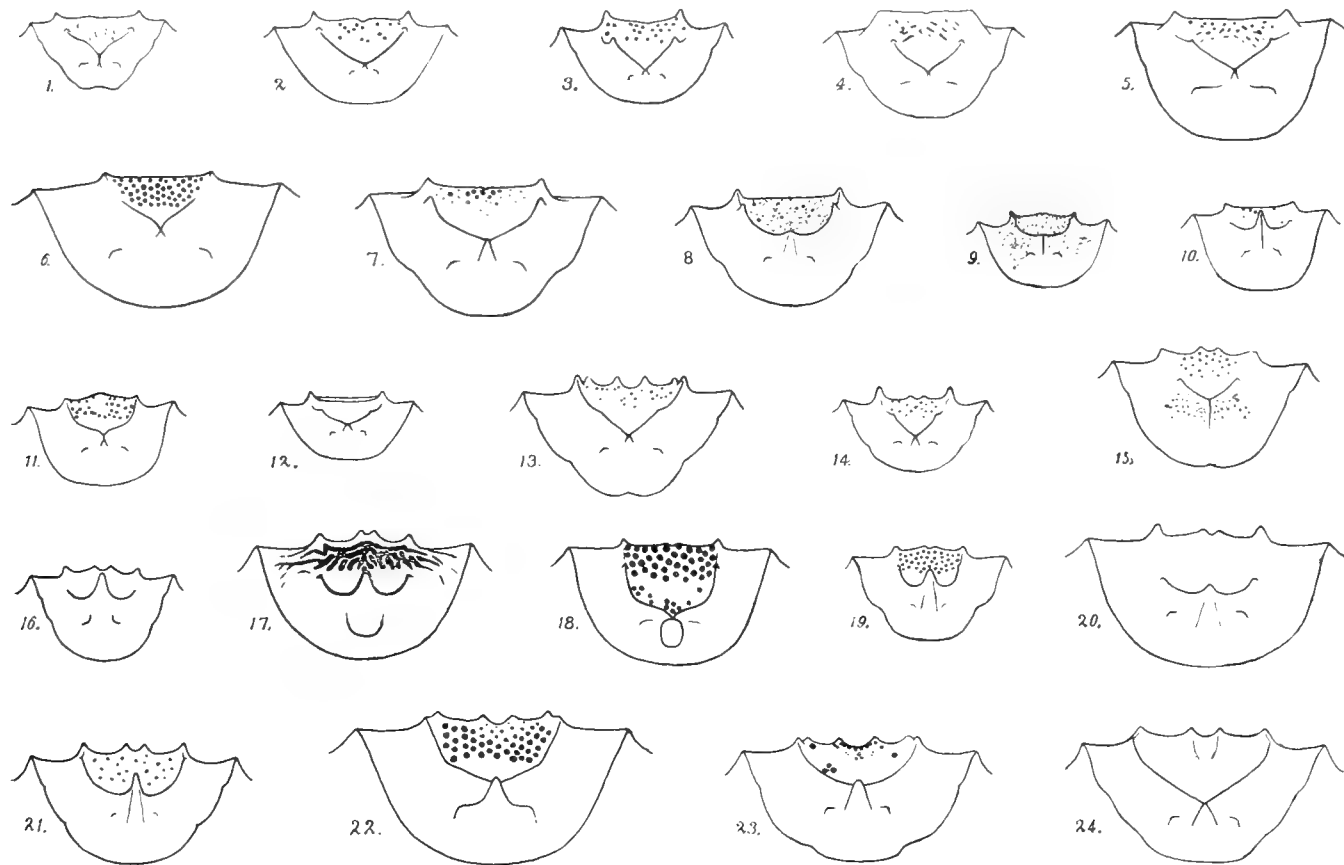


FIG. VII.

Passalus spp. ; specific characters in the upper surface of the head $\times 4$.

- | | |
|---|---|
| 1. <i>P. rugosus</i> , Gravelly. | 13. <i>P. interstitialis</i> , Eschscholtz. |
| 2. <i>P. punctato-striatus</i> , Percheron. | 14. <i>P. spinipes</i> , Gravelly. |
| 3. <i>P. rhodocanthopoides</i> (Kuwert). | 15. <i>P. abortivus</i> , Percheron. |
| 4. <i>P. morio</i> , Percheron. | 16. <i>P. mucronatus</i> , Burmeister. |
| 5. <i>P. latifrons</i> , Percheron. | 17. <i>P. quadricollis</i> , Eschscholtz. |
| 6. <i>P. pertyi</i> (Kaup). | 18. <i>P. occipitalis</i> , Eschscholtz. |
| 7. <i>P. quitensis</i> (Kaup). | 19. <i>P. nasutus</i> , Percheron. |
| 8. <i>P. catherinae</i> , Gravelly. | 20. <i>P. polli</i> , Gravelly. |
| 9. <i>P. eucadorensis</i> , Gravelly. | 21. <i>P. punctatissimus</i> , Eschscholtz. |
| 10. <i>P. curtus</i> (Kaup). | 22. <i>P. opacus</i> , Gravelly. |
| 11. <i>P. prominens</i> , Gravelly. | 23. <i>P. glaber</i> , Gravelly. |
| 12. <i>P. guatemalensis</i> (Kaup). | 24. <i>P. erosus</i> , Truqui. |

***Passalus rhodocanthopoides* (Kuwert).**

Fig. VII. 3.

Neleuops rhodocanthopoides, Kuwert, 1898, pp. 142-143.

Several specimens from Peru (Cumbasa and the Amazon region). Length 24-25 mm.

A somewhat flatter insect than the preceding, with the inner tubercles situated almost vertically behind the outer tubercles but separated from them by a well marked concavity. The posterior intermediate areas of the metasternum are coarsely punctured,

¹ One of the Mexican specimens has numerous small spines on these tibiae, and the Columbian specimen has them numerous and very strong. The latter specimen has the elytra more coarsely punctured than any other that I have seen and may prove to belong to a different species.

the lateral areas are hairy and punctured, as are also the epipleura and the shoulders and anterior half of the lower margin of the elytra. In other respects this species resembles the preceding one.

Passalus morio, Percheron.

Fig. VII, 4, p. 53.

Passalus morio, Percheron, 1835, pp. 83-84, pl. vi, fig. 4.

Sixteen specimens from Brazil (Espírito-Santo, Bahia, Blumenau, Rio). Length 10-27.5 mm.

This species is somewhat more convex than either of the two preceding. The length of the antennal lamellae is somewhat variable.

The head is very like that of *P. rhodocanthopoides*, but the outer tubercles are very obtuse, the anterior margin is somewhat thickened, the frontal area behind this thickening is flat with no special depression between the inner and outer tubercles, and the inner tubercles are situated much nearer together than the outer. The punctures on the pronotum are usually confined to the scars and marginal grooves, but may be absent from the former or may extend beyond them. The mesosternal scars are represented only by triangular matt areas which are not sunk below the level of the surrounding surface. The posterior intermediate areas of the metasternum are as a rule strongly punctured; the lateral areas are more or less linear, smooth or slightly roughened, with or without hair-bearing punctures. The epipleura are hairless and unpunctured, the puncturing of the elytra in this and other respects resembling that of *P. punctato-striatus*. The armature of the middle and hind tibiae is variable, never as strong as in *P. rugosus*.

Passalus latifrons, Percheron.

Fig. VII, 5, p. 53.

Passalus latifrons, Percheron, 1841, pp. 32-33, pl. lxxix, fig. 1.

Three specimens from Surinam, length 30.6-32.1 mm.

P. latifrons is very like *P. morio*, and will perhaps prove to be no more than a local race of it. The outer tubercles are more prominent and consequently less obtuse; the inner tubercles are less distinct; the frontal ridges diverge at a more obtuse angle and extend more distinctly beyond the latter towards the former. The anterior angles of the pronotum are produced forwards to form a somewhat obscure but distinctly acute projection. The punctures in the pronotal scars and on the posterior intermediate areas of the metasternum are few in number in all our specimens, and the lateral areas of the metasternum are smooth and hairless. The mesosternal scars are entirely absent.

Passalus pertyi (Kaup).

Fig. VII, 6, p. 53.

Pertinax pertyi, Kaup, 1869, p. 22.

Two specimens without locality labels. Length 39.0-41.5 mm.

The frontal area is smaller in all directions than in *P. latifrons* and more densely punctured in front. The inner tubercles are obsolete and the frontal ridges do not reach the outer tubercles. The anterior angles of the pronotum are strongly rounded. The

posterior intermediate areas of the metasternum are more extensively punctured than in *P. latifrons*, which the present species resembles in other respects.

***Passalus convexus*, Schönherr.**

Passalus convexus, Schönherr, 1817, p. 333, and appendix pp. 142-143.

Ten specimens from Cumbase (Peru), Tejuca, Upper Amazon, and Amazonas. Length 38.0-43.7 mm.

This species, like the last, is closely allied to *Passalus latifrons*, from which it differs only in its larger size, in not having the frontal ridges continued beyond the inner tubercles, in having less prominent outer tubercles, and in having the anterior angles of the pronotum more or less rounded.

***Passalus quitensis* (Kaup).**

Fig. VII, 7, p. 53.

Proculejus quitensis, Kaup, 1871, pp. 63-64.

Described from a cotype from Quito, lent by the British Museum. Length 32 mm.

In addition to its rounded pronotum and fused and rounded elytra *Passalus quitensis* differs from *P. convexus* in having the inner tubercles directly behind and much nearer to the outer tubercles, in having curved instead of straight frontal ridges, in having well developed mesosternal scars, and in having the posterior intermediate areas of the metasternum strongly and extensively punctured.

***Passalus affinis*, Percheron.**

Passalus affinis, Percheron, 1835, pp. 72-73, pl. v, fig. 5.

Several specimens from Cuba, three from St. Domingo and one from Haiti. Length 37.5-42.0 mm. Relative breadth very variable.

The frontal area resembles that of *P. quitensis*, but is more closely and extensively punctured in front, while the inner and outer tubercles are contiguous, together forming a pair of more or less oblique ridges on the anterior margin of the head, as in *P. interruptus*, etc. The mesosternal scars are well developed; the posterior intermediate areas of the metasternum are coarsely and extensively punctured. The lateral areas of the metasternum, the epipleura and the shoulders of the elytra are punctured and hairy. In other respects this species resembles *P. convexus*.

***Passalus catharinae*, n. sp.**

Fig. VII, 8, p. 53.

One specimen from Santa Catharina and one from Chaco. Length 31-33 mm.

The head is very like that of *P. affinis*, but the frontal ridges and all the tubercles are more strongly elevated, the broad and rectangular or obtuse apex of the central tubercle slightly overhanging the frontal area, which is more or less sparsely punctured. There are a few strong punctures above the pronotal scars. The posterior intermediate areas of the metasternum bear a few coalescent punctures along the inner margin; the lateral areas are linear, hairless and unpunctured. The elytra resemble those of *P. affinis* except that the dorsal ridges are less and the lateral more coarsely punctured, the three grooves

nearest the suture being unpunctured, the fourth containing more or less obsolete punctures, the fifth and sixth containing strong round punctures, and the seventh, eighth and ninth containing larger and more or less transverse punctures. In other respects this species resembles *P. affinis*.

***Passalus recticlypeatus* (Kuwert).**

Petrejus recticlypeatus, Kuwert, 1898, p. 202.

Four specimens, without locality record. Length 23.3–24.7 mm.

This species is very like the preceding one, but is smaller and has the apex of the central tubercle acute, free and directed forwards above the finely roughened but unpunctured frontal area, the inner tubercles being obsolete or absent. The posterior intermediate areas of the metasternum are almost or quite unpunctured; the lateral areas are more or less rugose and bear a few fine hairs. The lateral grooves of the elytra, though much more strongly punctured than the dorsal, are less strongly punctured than in *Passalus catherinae*, which this species resembles in other respects.

***Passalus eucadorensis*, n. sp.**

Fig. VII, 9, p. 53.

One specimen from Ecuador, 20.4 mm. long.

In this species the cephalic tubercles and ridges resemble those of *P. catherinae*, except that the central tubercle is weaker; otherwise the insect resembles *P. recticlypeatus*, except that the anterior margin of the head is slightly prominent in the middle line, and that the metasternum and elytra are entirely hairless.

***Passalus curtus* (Kaup).**

Fig. VII, 10, p. 53.

Petrejus curtus, Kaup, 1869, p. 38.

One specimen from the Cauca Valley, 23.3 mm. long.

The free apex of the central tubercle is longer than in *P. recticlypeatus*, but the frontal ridges are less strongly elevated and become obsolete in front. The frontal area is irregularly marked with coarse punctures. The sides of the pronotum and the posterior intermediate areas of the metasternum are somewhat more extensively punctured. The mesosternal scars and the lateral areas of the metasternum are finely punctured and hairy. The epipleura are without, and the shoulders of the elytra almost without, hair-bearing punctures. The puncturing of the dorsal grooves of the elytra is about as coarse as that of the lateral grooves. In other respects this species resembles *P. recticlypeatus*.

***Passalus gracilis* (Kaup).**

Petrejus gracilis, Kaup, 1869, p. 38.

One specimen from Columbia, 16.5 mm. long.

A much smaller species than the preceding, with more flattened central tubercle, conical forwardly directed parietal ridges, somewhat more distinct frontal ridges, smooth

unpunctured frontal area, hairless mesosternal scars, metasternal lateral areas and elytra shoulders, and less coarsely punctured dorsal grooves on the elytra.

***Passalus prominens*, n. sp.**

Fig. VII, 11, p. 53.

One specimen from the Peruvian Amazon, 22 mm. long, and somewhat convex.

The anterior margin of the head is slightly prominent as in *P. eucadorensis*, forming an obtuse angle in the middle line; but the frontal area is larger, being quite half as long as it is wide in front, and its general surface is smooth and somewhat sparsely marked with large punctures instead of being finely roughened all over. The central tubercle is laterally compressed, with an antero-posteriorly obtuse apex situated behind the junction of the frontal ridges. The frontal tubercles are obsolete. In other respects this species resembles *P. gracilis*, except that the anterior angles of the pronotum are more acute and the posterior angles (like the hind part of the posterior intermediate areas of the metasternum) are somewhat densely punctured, the anterior ends of the marginal grooves being densely punctured and strongly enlarged.

***Passalus guatemalensis* (Kaup).**

Fig. VII, 12, p. 53.

Oileus guatemalensis, Kaup, 1869, p. 6.

Three specimens from Nicaragua, 19.6–20.3 mm. long.

Passalus guatemalensis differs from all other species of *Passalus* known to me in having a vertical and more or less conspicuously exposed clypeus. It should perhaps be regarded as the type of a distinct genus allied to *Vindex*, but such a course would hardly be justifiable at present.

P. guatemalensis is a somewhat flatter insect than the last, with a more or less punctured obtuse-angled frontal area, the frontal tubercles being situated about half way between the less prominent central and more prominent outer tubercles. The margin of the head between the outer tubercles is straight, with or without a median notch. The sides of the pronotum are somewhat rounded, and the anterior angles are not acute; the median groove is complete, and the anterior ends of the marginal grooves are scarcely enlarged or punctured; the scars are transverse and punctured, with a longitudinal band of punctures above them. In other respects this species resembles *P. prominens*, except that the punctures on the posterior intermediate areas of the metasternum are more widely dispersed.

***Passalus incertus*, Percheron.**

Passalus incertus, Percheron, 1841, pp. 27-28, pl. lxxviii, fig. 4.

Six specimens from the Cauca Valley, and one from Venezuela. Length 19.4–24.3 mm.

A slender and somewhat flattened insect, differing from the last only in having the clypeus entirely hidden, the median notch of the anterior margin of the head sometimes

very pronounced, the frontal area more or less rugose but unpunctured, the frontal ridges strongly arched, the inner and outer tubercles nearer together, the anterior ends of the marginal grooves of the pronotum more strongly dilated and punctured, the sides of the pronotum more extensively punctured in small and less in large specimens, the posterior intermediate areas of the metasternum less strongly and extensively punctured, the grooves of the elytra somewhat more strongly punctured, and the shoulders and epipleura punctured and hairy. The spines on the middle tibiae are variable in number ; in none of our specimens are they very strong.

Passalus interstitialis, Eschscholtz.

Fig. VII, 13, p. 53.

Passalus interstitialis, Eschscholtz, 1829, pp. 18-19.

One or more (often numerous) specimens from each of the following localities :—Mexico, Guatemala, Honduras (San Pedro Sula), Panama (Chiriqui), Cuba, Surinam, Peru (Cumbase and Amazon), Brazil (Amazonas, Pernambuco, Bahia, Rio and Blumenau), Bolivia (Cordico and Farinas) and Paraguay. Length 24–34 mm.

The anterior margin of the head is much more extensively notched in the middle line than in the preceding species, and the notch is bounded by a pair of very prominent tubercles. These tubercles are fully as strong as the outer tubercles, which are somewhat small and are more or less obscured by the inner tubercles, the latter being very long and projecting from a point contiguous to and a little behind and on the outer side of them. From the inner tubercles the imperfectly denticulate frontal ridges extend in a straight line backwards and inwards to meet in a right or slightly obtuse angle. The anterior part of the frontal area is more or less punctured.

The pronotum resembles that of the preceding species in shape and is more or less extensively punctured at the sides, but the anterior ends of the marginal grooves are not expanded. The mesothorax is normal. The posterior intermediate areas of the metasternum are closely and coarsely punctured ; the lateral areas are moderately broad and are covered with hair-bearing punctures. The dorsal grooves of the elytra are strongly but finely punctured, the lateral grooves are coarsely punctured. The epipleura shoulders and anterior half or two-thirds of the outermost rib of the elytra are thickly covered with hair-bearing punctures. The middle tibiae are armed with one stout spine.

Passalus glaberrimus, Eschscholtz.

Passalus glaberrimus, Eschscholtz, 1829, p. 20.

Four specimens, of which three are from Brazil (Blumenau and Rio), and one bears no record. Length 20 mm.

Passalus glaberrimus is very like *P. incertus*, but has the anterior margin of the head more definitely notched than is usual in that species, the sides of the pronotum usually more extensively punctured, the anterior angles of the pronotum somewhat more acute and the elytra devoid of hair-bearing punctures.

Passalus spinosus (Kuwert).

Rhodocanthopus incertus, Kuwert, 1898, p. 140.

Two specimens from Chiriqui, Panama, 20.3 mm. long. A somewhat more robust insect than the preceding.

The frontal ridges are straight and meet in a right angle; the inner tubercles are situated about half way from the central to the outer tubercles and there is a pair of small secondary tubercles between them and the latter; the anterior margin of the head is broadly notched in the middle; the anterior part of the frontal area is moderately strongly punctured. The pronotum resembles that of *P. incertus* in shape, but is only punctured in and close to the scars and in the marginal grooves, whose anterior ends are smaller. The mesothorax resembles that of *P. incertus*. The metasternum differs from that of *P. incertus* only in having the lateral areas somewhat broader and less smooth behind. The elytra are hairless; their four dorsal grooves are about as strongly punctured as in *P. incertus*; the next four are marked with very large transverse punctures, the transverse ridges between which tend to become obsolete behind. In the two remaining grooves these ridges are obsolete throughout, and at the extreme posterior end the longitudinal ridges become obsolete also, the remaining surface being matt. The middle and hind tibiae are armed with three or four strong spines.

Passalus spinipes, n. sp.

Fig. VII, 14, p. 53.

One specimen from Nicaragua, 22.7 mm. long.

This species is closely allied to *P. spinosus*, but the inner tubercles and the secondary tubercles in front of them are less pronounced, the sides of the pronotum bear a longitudinal band of punctures above the scars, the posterior intermediate areas of the metasternum are less extensively punctured, the lateral areas are extremely narrow throughout, the punctures in the grooves of the elytra are finer, those in the lateral grooves though moderately coarse not being transverse.

Passalus spiniger (Bates).

Rhodocanthopus spiniger, Bates, 1886, pp. 15-16, pl. 1, figs. 16-16a.

One specimen from Columbia, 22 mm. long.

This species is very like the last two, but the anterior margin of the head is less broadly and perhaps more sharply notched, the frontal area is scarcely as long or as distinctly punctured, there are no secondary tubercles between the inner and outer tubercles, the sides of the pronotum are more coarsely and extensively punctured, the lateral areas of the metasternum are intermediate between the two in width, and the puncturing of the grooves of the elytra is somewhat coarser than in *P. spinosus* above and less coarse (scarcely if at all transverse) at the sides, all the transverse ridges being distinct and broadly elevated as in *P. spinipes*.

Passalus abortivus, Percheron.

Fig. VII, 15, p. 53.

Passalus abortivus, Percheron, 1835, pp. 87-89, pl. vi, fig. 7.

Three specimens from the Amazon, of which at least two are from Peru. Length 28.0-28.3 mm. long. One specimen with deformed antennae.

This species differs from all other species of *Passalus* known to me in sometimes having a distinct lamella in front of the three ordinarily found on the antennae of species of this genus. This lamella, however, is not fully developed as are the additional lamellae found in the genus *Paxillus*, but is either much slenderer than those following it as well as only about half their length, or is quite short and inconspicuous.¹ The anterior margin of the head bears a pair of small but well developed tubercles on either side of the median notch, which is consequently much more pronounced than is ever the case in *Paxillus*. The cephalic tubercles and ridges closely resemble those of *Passalus spiniger*. The pronotum resembles that of *P. spiniger* in shape, but is unpunctured except in the scars and marginal grooves. An oval patch a little below the middle of the mesothoracic episterna, the mesosternal scars, the lateral areas of the metasternum, and the lower parts of the shoulders of the elytra (but not the epipleura) are covered with hair-bearing punctures. The posterior intermediate areas of the metasternum are coarsely punctured behind and on the inner side. The elytra are strongly and uniformly punctured. The middle and hind tibiae bear from one to three spines which are stronger on the former than on the latter.

Passalus jansoni (Bates).*Phoroneus jansoni*, Bates, 1886, p. 18, pl. i, figs. 17-17a.

One specimen from Nicaragua, 32 mm. long.

This species is very like the last, but the triconcave margin of the head between the outer tubercles is thickened and lightly convex as a whole; the frontal area and the pronotum (even in the scars and anteriorly weak marginal grooves) are unpunctured; the mesothoracic episterna, the mesosternal scars, the metasternum and the elytra are hairless, the second and third being entirely unpunctured, and the last being punctured in the lateral grooves only; and there are no very distinct spines on the middle and hind tibiae.

Passalus mucronatus, Burmeister.

Fig. VII, 16, p. 53.

Passalus mucronatus, Burmeister, 1847, pp. 488-489.

One specimen from Columbia and one from Guatemala. Length 24 mm.

The head and pronotum resemble those of the preceding species in outline, but the central tubercle is much elongated with free decumbent apex, the frontal ridges are feebly developed, the anterior margin of the head is not thickened, and the sides of the pronotum, including the scars and anteriorly enlarged marginal grooves, are strongly punctured. The

¹ In one of our two specimens in which the antennae are not deformed it is slender and about half the length of the others; in the other it is scarcely if at all different from the enlargement often found in the same position in other species.

mesothorax is normal. There are a number of coarse punctures on the posterior intermediate areas of the metasternum, the lateral areas being linear, smooth and hairless. The anterior intermediate areas of the metasternum, and the shoulders of the elytra with the anterior parts of the epipleura, are covered with hair-bearing punctures, the shoulders of the elytra being densely hairy. All the grooves of the elytra are distinctly punctured, the lateral scarcely more strongly than the dorsal. The middle and hind tibiae are without distinct spines.

***Passalus quadricollis*, Eschscholtz.**

Fig. VII, 17, p. 53.

Passalus quadricollis, Eschscholtz, 1892, pp. 21-22.

Phoroneus quadricollis, Kaup, 1871, p. 102.

Two specimens from Brazil, one of them in the collection of M. Guy Babault of Paris. Length 33 mm.

The central tubercle is set further back than in *P. mucronatus* and the free apex extends forwards horizontally at right angles to the massive base by which it is raised high above the large and coarsely rugose frontal area. The frontal ridges and inner tubercles are more strongly developed than in *P. mucronatus*. The pronotum resembles that of *P. mucronatus*, except that the punctures are confined to the scars and marginal grooves, those in the former being of very large size. The mesosternal scars are matt, but are not depressed. The inner angles of the posterior intermediate areas of the metasternum are marked with very large and more or less coalescent punctures; the anterior intermediate and lateral areas of the metasternum and the shoulders of the elytra are covered with hair-bearing punctures. The grooves of the elytra are marked with shallow punctures which are very broad in the lateral grooves. The middle tibiae bear a stout spine on the outer side.

***Passalus occipitalis*, Eschscholtz, 1829.**

Fig. VII, 18, p. 53.

Passalus occipitalis, Eschscholtz, 1829, p. 21.

One specimen 33 mm. long. Locality not recorded.

This species is closely related to the last, but the massive central tubercle is set still further back and has no free horizontal apex. The frontal ridges diverge at about a right angle and then bend forwards and run parallel to one another as far as the inner tubercles, which are situated not very far behind the outer. The anterior margin of the head, though straight as a whole, is a little irregular; it is not distinctly notched in our specimen;¹ the whole anterior part of the frontal area is thickly covered with large punctures. The whole of the thorax resembles that of *P. quadricollis*, except that the mesothoracic scars are to some extent depressed, and the punctures in the inner angles of the posterior intermediate areas of the metasternum are much smaller. The elytra are punctured as in that species in the lateral grooves, more finely or not at all in the dorsal ones. The legs resemble those of that species.

¹ See also, however, Arrow, 1907, pp. 459-460.

Passalus nasutus, Percheron.

Fig. VII, 19, p. 53.

Passalus nasutus, Percheron, 1835, pp. 90-91, pl. vi, fig. 8.

One specimen from Parana, 24.4 mm. long.

This species resembles the preceding, but is much smaller; the central tubercle is conical, free distally and directed forwards and a little upwards; the pronotum has less acute anterior angles and somewhat more numerous punctures in the scars; the epipleura and shoulders of the elytra are densely covered with hair-bearing punctures; the grooves of the elytra are punctured much as in *P. quadricollis*.

Passalus polli, n. sp.

Fig. VII, 20, p. 53.

One specimen from Joinville, 34.5 mm. long.

Passalus polli is much larger than *P. nasutus* and has a smaller central tubercle situated somewhat further forwards, whose apex is scarcely free. The frontal ridges are small and extend almost directly outwards, then arching slightly forwards to end in the inner tubercles, which are equidistant from the central and outer tubercles; the whole surface of the head in front of the inner tubercles is rugose and glossy. The anterior ends of the marginal grooves are somewhat curved but scarcely expanded. The mesosternal scars are depressed and covered with moderately large, indistinct, coalescent punctures. The posterior intermediate areas of the metasternum are closely covered with coarse punctures; the lateral areas are very broad, especially behind, and are covered with hair-bearing punctures. The puncturing of the grooves of the elytra resembles that of *P. quadricollis*, but is somewhat deeper laterally; the shoulders, epipleura and anterior half of the rib immediately above each of the thickened lateral margins are covered with hair-bearing punctures. The middle and hind tibiae are each armed with one stout spine.

Passalus toriferus, Eschscholtz.*Passalus toriferus*, Eschscholtz, 1829, pp. 17-18.

Three specimens from Brazil, one from Yucatan, and one said (no doubt incorrectly) to come from S. Australia. Length 28-34 mm.

This species differs from the last only in having the anterior part of the head less rugose (the frontal area sometimes punctured), the inner tubercles situated close behind and slightly on the outer side of the outer tubercles, the sides of the pronotum strongly and coarsely punctured at least near the scars, and the extreme anterior part of the eighth groove of the elytra hairy. The central tubercle is very variable and may be distinctly or not at all free distally.

Passalus punctatissimus, Eschscholtz.

Fig. VII, 21, p. 53.

Passalus punctatissimus, Eschscholtz, 1829, pp. 19-20.

A number of specimens from the Peruvian and Upper Amazon, two from Rio and one from Blumenau. Length 26.5-30.0 mm. Also one specimen 34.2 mm. long, said to

come from Queensland. This specimen has hairy mesosternal scars and may belong to a distinct species.

Passalus punctatissimus differs from *P. toriferus* chiefly in having all the cephalic tubercles longer and more acute, and in not having the eighth groove of the elytra hairy in front. The frontal area may be partially or not at all punctured. The anterior ends of the marginal grooves of the pronotum are not expanded but may be somewhat curved. The pronotum is sometimes wider in front than behind, with acutely produced anterior angles.¹ The outermost rib of the elytra is sometimes hairy throughout instead of only in its anterior half.² The last two variations may perhaps indicate a tendency for the species to split up into various local races, but more material is needed to settle this.

***Passalus unicornis*, Saint-Fargeau and Serville.**

Passalus unicornis, Saint-Fargeau and Serville, 1825, p. 20.

Six specimens from Guadeloupe, 38.5–42.0 mm. long.

The central tubercle is extremely long and slender, much more so than in the preceding species, but the other cephalic tubercles are much less prominent and more obtuse than in that species. The pronotum is unpunctured, except in the uniformly narrow marginal grooves, and in and close to the scars. The epipleura, shoulders, tips, and eighth and tenth (usually also the ninth to a less extent) ribs of the elytra are covered with hair-bearing punctures.

***Passalus opacus*, n. sp.**

Fig. VII, 22, p. 53.

One specimen from Farinas, Bolivia, 39.5 mm. long.

The whole surface of this insect is dull as in *P. languidus* (Kuwert, 1898, p. 275), from which it differs in having all the grooves of the elytra much more strongly punctured. Apart from its dulled surface *P. opacus* differs from *P. unicornis* in having the head more rugose with a much shorter central tubercle, the sides of the pronotum more extensively punctured, the marginal grooves of the pronotum very broad in front of the scars, the mesosternal scars indistinct, no hair on the ribs of the elytra above or behind the extreme anterior part of the tenth, and all the grooves of the elytra much more coarsely punctured, the punctures in the lateral grooves being transverse.

***Passalus interruptus* (Linnaeus).**

Lucanus interruptus, Linnaeus, 1767, p. 560.³

One or more (often numerous) specimens from each of the following localities:—Texas, Mexico, Guatemala (including one specimen from Escuintla), Honduras (San Pedro Sula), Nicaragua, Panama (Chiriqui), Columbia, Venezuela (Caracas), Guiana (Demerara, Surinam, Cayenne), Peruvian Amazon, Upper Amazon, Brazil (Amazonas, Pernambuco,

¹ This is most marked in the series from the Upper Amazon.

² This is so in the two specimens from the Peruvian Amazon.

³ This is the reference usually given, but Linnaeus himself described the species at greater length in 1764 (p. 33) and refers there to yet earlier descriptions. I have been unable to consult these and cannot say in which or by whom the name *interruptus* was first introduced.

Bahia, Petropolis, Rio de Janeiro, Santa Catharina, Blumenau) and Bolivia (Farinas and S. Antonia). Length 17-51 mm.

This appears to be a very common, widely distributed and variable species. Large specimens may be as much as three times as long as small ones, are much more robust-looking, have the sides of the pronotum unpunctured except in the scars and marginal grooves instead of extensively punctured, have the dorsal grooves of the elytra smooth instead of distinctly punctured and have the lateral grooves moderately strongly instead of very coarsely punctured.¹ The mesosternal scars are usually deep, narrow and smooth as in *P. unicornis*, but may be larger and more irregular, with or without a few hair-bearing punctures, or the whole of the sides of the mesosternum may be densely covered with hair-bearing punctures. The hair on the elytra is usually distributed as in *P. opacus*, but may be more extensive as in *P. unicornis*.

P. interruptus differs from *P. opacus* in having the surface of the body glossy and the punctures in the grooves of the elytra much less coarse, the lateral ones not being transverse. In these characters it resembles *P. unicornis*, from which it differs in having a much shorter central tubercle.

Passalus glaber, n. sp.

Fig. VII, 23, p. 53.

One specimen without locality record. Length 37 mm.

This species is very like the last, but has only a few hair-bearing punctures on the elytra, these being confined to the lower parts of the shoulders immediately in front of the epipleura; it has the mesosternal scars replaced by broad matt areas which are not sunk below the general level of the plate; and it has the metasternum somewhat less extensively punctured.

Passalus binominatus, Percheron.

Passalus binominatus, Percheron, 1841, pp. 23-24.

One specimen from Santa Catharina, 32 mm. long.

The secondary tubercles on the anterior margin of the head are less widely separated, and although the frontal ridges are lightly arched the frontal area is more nearly triangular than semicircular. The central tubercle is obtuse and has no free forwardly directed apex. There are no coarse punctures on the general surface of the pronotum. The mesosternal scars are entirely absent. There are only a few coarse punctures on the inner side of the posterior intermediate areas of the metasternum. In all other respects this species resembles *P. glaber*.

Passalus erosus, Truqui.

Fig. VII, 24, p. 53.

Passalus erosus, Truqui, 1857, p. 268.

One specimen doubtfully recorded from Brazil, and one said (doubtless incorrectly) to have come from India. Length 35-36 mm.

¹ The punctures in the lateral grooves are really of about the same size in all specimens; consequently they are proportionally larger and look much coarser in small than in big ones.

This species differs from the last only in the form of the frontal area, which is slightly longer in proportion to its width and is more or less distinctly grooved in continuation of the median notch on the anterior margin.

The species of *Passalus* known to me may be distinguished from one another thus:—

- | | | | |
|---|---|---|--------------------------------------|
| 1 | { | The punctures in the grooves of the elytra extremely coarse, transverse laterally; the anterior margin of the head straight between the outer tubercles; the lateral areas of the metasternum hairless (small insects only) | 2. |
| | | The punctures in the grooves of the elytra less coarse, not transverse laterally; or, the anterior margin of the head strongly notched in the middle; or, the lateral areas of the metasternum hairy | 3. |
| 2 | { | The epipleura hairless | <i>P. nanus</i> , p. 52. |
| | | The epipleura hairy | <i>P. rugosus</i> , p. 52. |
| 3 | { | The anterior margin of the head straight or simply notched in the middle, without secondary tubercles; the frontal area large, with the central tubercle about half as far from the anterior margin as the outer tubercles are from each other, and with the frontal ridges usually straight and diverging at about a right angle; the central tubercle small, without free apex; the outer tubercles prominent, the inner tubercles usually situated very near them, always nearer to them than to the central tubercle; the lateral areas of the metasternum, and the epipleura and shoulders of the elytra, hairless | <i>P. punctato-striatus</i> , p. 52. |
| | | Not as above | 4. |
| 4 | { | The anterior margin of the head straight between the outer tubercles; the clypeus entirely hidden; the central tubercle small with no trace of free apex; the inner tubercles usually much less widely separated than the outer, and when distinct always situated a considerable distance behind them; the frontal ridges straight, not arched, meeting in a distinct though sometimes more or less obtuse angle; the epipleura usually hairless, when hairy the lateral areas of the metasternum always hairy also | 5. |
| | | Not as above | 9. |
| 5 | { | The inner and outer tubercles equally widely separated, the former situated at a considerable distance behind the latter; the epipleura densely hairy | <i>P. rhodocanthopoides</i> , p. 53. |
| | | Not as above | 6. |
| 6 | { | The anterior margin of the head usually somewhat thickened; the outer tubercles obsolete, obtuse; the frontal ridges ending in the inner tubercles, which are very pronounced and are situated about half way between the central and outer tubercles | <i>P. morio</i> , p. 54. |
| | | Not as above | 7. |

- 7 { The anterior angles of the pronotum produced to form a pair
of small but distinctly acute forwardly-directed processes *P. latifrons*, p. 54.
The anterior angles of the pronotum not so produced 8.
- 8 { The frontal area small, coarsely and closely punctured in front *P. pertyi*, p. 54.
The frontal area large, smooth or rugose with a few large
punctures in front *P. convexus*, p. 55.
- 9 { The elytra fused, their vertical anterior part lightly convex *P. quitensis*, p. 55.
The elytra separate, their vertical anterior part not convex 10.
- 10 { The anterior margin of the head straight between the outer
tubercles or very faintly notched in the middle; the lateral
areas of the metasternum hairy *P. affinis*, p. 55.
The anterior margin of the head strongly notched or provided
with secondary tubercles between the outer tubercles; or
the lateral areas of the metasternum hairless 11.
- 11 { The frontal area about three times as wide as long, broadly
rounded and not angular behind; the anterior margin of the
head straight or lightly convex between the outer tubercles 12.
The frontal area about twice as wide as long, or angular
behind; the anterior margin of the head usually notched
or provided with secondary tubercles between the outer
tubercles 16.
- 12 { The central tubercle without very long and slender free apex;
the frontal ridges strong 13.
The central tubercle with long and slender free apex; the
frontal ridges weak 15.
- 13 { The epipleura hairy, the apex of the central tubercle more or
less free 14.
The epipleura hairless; the apex of the central tubercle not free *P. euacadorensis*, p. 56.
- 14 { The apex of the central tubercle scarcely free, somewhat blunt *P. catherinae*, p. 55.
The apex of the central tubercle distinctly free, sharper .. *P. recticlypeatus*, p. 56.
- 15 { The lateral areas of the metasternum hairy *P. curtus*, p. 56.
The lateral areas of the metasternum hairless *P. gracilis*, p. 56.
- 16 { The anterior margin of the head convex between the outer
tubercles, but without median notch or secondary tubercles.. *P. prominens*, p. 57.
Not as above 17.
- 17 { The clypeus to some extent exposed as a more or less vertical
(slightly overhanging) plate between the frons and the
labrum *P. guatemalensis*, p. 57.
The clypeus entirely hidden 18.
- 18 { The lateral areas of the metasternum hairless; the epipleura
hairy throughout; the central tubercle without free apex.. *P. incertus*, p. 57.
Not as above 19.

- 19 { The inner tubercles large, directed forwards above the somewhat smaller outer tubercles, close behind the outer side of which they are situated; a pair of well developed and somewhat widely separated secondary tubercles present between the outer tubercles; the frontal ridges straight, meeting in a right or slightly obtuse angle; the lateral areas of the metasternum, and the epipleura, shoulders and anterior parts of the sides of the elytra densely hairy .. *P. interstitialis*, p. 58.
 Not as above 20.
- 20 { The central tubercle small, without free apex, normal; the anterior margin of the head not thickened; the lateral areas of the metasternum hairless 21.
 Not as above 24.
- 21 { The middle and hind tibiae armed with at most one small spine *P. glaberrimus*, p. 58.
 The middle and hind tibiae more extensively armed 22.
- 22 { The pronotum punctured only in the marginal grooves and in and immediately above the scars *P. spinosus*, p. 59.
 The sides of the pronotum with an extensive band of punctures above the scars 23.
- 23 { The grooves of the elytra somewhat finely punctured .. *P. spinipes*, p. 59.
 The grooves of the elytra very coarsely punctured .. *P. spiniger*, p. 59.
- 24 { The inner and outer tubercles clearly separate; the former never more distant from one another than the latter, sometimes more or less obsolete 25.
 The inner and outer tubercles situated close together, forming together a pair of small oblique ridges on the anterior margin of the head, with the former tubercles somewhat more distant from one another than the latter 31.
- 25 { The epipleura hairless, or the central tubercle with free apex 26.
 The epipleura densely hairy; the central tubercle without free apex *P. polli*, p. 62.
- 26 { The central tubercle without free apex, normal 27.
 The central tubercle with free apex, or more or less columnar 28.
- 27 { The lateral areas of the metasternum hairy; a more or less rudimentary fourth lamella often recognizable on the antennae *P. abortivus*, p. 60.
 The lateral areas of the metasternum hairless *P. jansoni*, p. 60.
- 28 { The frontal area fully twice as broad as long; the central tubercle decumbent throughout, with long slender free apex; the lateral areas of the metasternum hairless *P. mucronatus*, p. 60.
 The frontal area less than twice as broad as long; the lateral areas of the metasternum more or less hairy 29.
- 29 { The central tubercle strongly elevated at base, massive, with small decumbent forwardly directed free apex .. *P. quadricollis*, p. 61.
 The central tubercle not having this form 30.

- | | | | | |
|----|---|---|-----------------------------------|-----|
| 30 | { | The central tubercle erect, more or less columnar, broadly rounded above | <i>P. occipitalis</i> , p. 61. | |
| | | The central tubercle decumbent throughout, with slender free apex | <i>P. nasutus</i> , p. 62. | |
| 31 | { | The epipleura densely hairy | | 32. |
| | | The epipleura hairless | | 36. |
| 32 | { | The general surface glossy; the punctures in the lateral grooves of the elytra coarse but scarcely transverse | | 33. |
| | | The general surface quite dull; the punctures in the lateral grooves of the elytra very coarse, more or less transverse . | <i>P. opacus</i> , p. 63. | |
| 33 | { | The frontal area less than twice as broad as long; the central tubercle without free apex | <i>P. toriferus</i> , p. 62. | |
| | | The frontal area more than twice as broad as long; or the central tubercle with free apex | | 34. |
| 34 | { | The central tubercle with long and slender free apex | | 35. |
| | | The central tubercle not extensively free | <i>P. interruptus</i> , p. 63. | |
| 35 | { | The eighth ribs of the elytra hairless and unpunctured throughout | <i>P. punctatissimus</i> , p. 62. | |
| | | The eighth ribs of the elytra punctured and hairy, especially in front | <i>P. unicornis</i> , p. 63. | |
| 36 | { | The frontal area more than twice as broad as long | <i>P. glaber</i> , p. 64. | |
| | | The frontal area less than twice as broad as long | | 37. |
| 37 | { | The frontal area not grooved in continuation of the median concavity between the secondary tubercles on the anterior margin | <i>P. binominatus</i> , p. 64. | |
| | | The frontal area grooved medially in front, in continuation with the concavity between the secondary tubercles on the anterior margin | <i>P. erosus</i> , p. 64. | |

Genus **PTICHOPUS**, Kaup, 1869, p. 27.

Type, *Passalus angulatus*, Percheron, 1835, pp. 84-86, pl. vi, fig. 5.

Ptichopus angulatus (Percheron).

Passalus angulatus, Percheron, 1835, pp. 84-86, pl. vi, fig. 5.

Several specimens from Mexico, Guatemala, Honduras (San Pedro Sula), and Nicaragua. Length 24-35 mm. These specimens show the species to be a somewhat variable one, even in the characters used by Kuwert to distinguish others from it; and the validity of species thus distinguished seems very doubtful. The generic definition, therefore will probably suffice for the identification of the present form, which is very unlike any other Passalid known to me.

Subfamily **SOLENOCYCLINAE**.

The characteristics of this subfamily have been discussed and defined above (pp. 10-13).

Specimens from Madagascar are characterized by the presence of a pair of more or less pronounced marginal tubercles immediately on the inner side of the fronto-vertical

suture, no tubercles being developed in this position in specimens from Africa. Kuwert has, it is true, described from Madagascar one species of each of his otherwise purely African genera *Erionomus* and *Didimoides*; but it remains to be seen whether he was right. In the case of the former genus the sentence "Der ganze Clypeus in der Breite der ganzen Oberlippe scharf vorgezogen" suggests, for instance, that *studi* may belong in reality to the new genus *Malagasalus*, established below to receive the only species of Solenocyclinae known to me in which the clypeus is exposed, and the pair of marginal tubercles most characteristic of the family as a whole—i.e., those immediately above the lateral extremities of the clypeus—are entirely absent.

None of the Malagasy genera hitherto described contain very many species; and the differences between them may advantageously I think be regarded as specific rather than generic. I propose, therefore, to unite all of them under the name *Solenocyclus*.

Some of the African genera appear to be decidedly larger; but in spite of this I am unable to find satisfactory characters by which to define more than two. I propose, therefore, to unite under the name *Pentalobus*, Kaup, all species with hairy sides to the metasternum and a more or less distinct tubercle or pair of tubercles or excavation in the middle of the anterior margin of the head; and to unite under the name *Erionomus*, Kaup, all species in which the sides of the metasternum are hairless and the middle of the anterior margin of the head is straight.

The genera of Solenocyclinae may now be defined as follows:—

1	{	A more or less distinct pair of marginal tubercles present immediately on the inner side of the fronto-vertical sutures (Malagasy forms)	..	..	..	..	..	..	2.
		Tubercles not present in this position (African forms)	..	..	..	..	..	..	3.
2	{	The clypeus exposed	..	..	..	..	<i>Malagasalus</i> , p. 69.		
		The clypeus hidden	..	..	..	..	<i>Solenocyclus</i> , p. 70.		
3	{	The sides of the metasternum hairless; the anterior margin of the head more or less distinctly notched in the middle line, or with a median tubercle	..	..	..	..	<i>Pentalobus</i> , p. 72.		
		The sides of the metasternum hairy; the anterior margin of the head without any median notch or tubercle	..	..	..	..	<i>Erionomus</i> , p. 74.		

Genus **MALAGASALUS**, n. gen.

Type, *Malagasalus clypeatus*, n. sp.

The clypeus exposed; a pair of marginal tubercles present immediately on the inner side of the fronto-vertical sutures; the sides of the metasternum hairless.

Malagasalus clypeatus, n. sp.

Fig. VIII, 1, p. 70.

Two specimens from Fenerive, Madagascar. Length 34 mm.

The antennae each have three well developed lamellae. The labrum is concave in front, convex at the sides, slightly narrower behind than in front. The central tubercle is strongly elevated above the short parietal ridges, but is somewhat obtuse. The frontal ridges diverge from it in an angle of about 90°; they extend to the strongly developed

inner tubercles, which are directed obliquely upwards and are in contact anteriorly with the still larger, but more forwardly directed outer tubercles. The outer tubercles are separated by a distance which is less than the width of the labrum ; they are equidistant from each other and from the tubercles on the inner side of the fronto-vertical suture, which are almost equally large. The clypeus is exposed, but is directed almost vertically downwards.

The pronotum is slightly wider behind than in front, and its anterior angles are obtuse. Its anterior margin is straight, and its posterior margin lightly convex. The marginal groove is somewhat widely incomplete in front, and is strongly punctured. The median groove is strong and complete. The scars are punctured, and there may be a few punctures in the anterior angles. The surface of the prothorax is closely punctured and hairy, but the hair is not very long. The mesosternum is smooth and glossy, with large and deeply impressed roughened scars. The anterior intermediate areas of the metasternum are somewhat coarsely and sparsely, and the lateral areas more finely and densely punctured and hairy, the latter being, however, to some extent roughened and hairless behind. A somewhat extensive patch of close, coarse, hairless punctures is present beside the posterior margin of the posterior intermediate areas, and a band of finer hair-bearing punctures extends from behind this patch outwards along the posterior margin to the posterior angles. The elytra are hairless, with the lateral grooves strongly and the dorsal somewhat more weakly punctured.

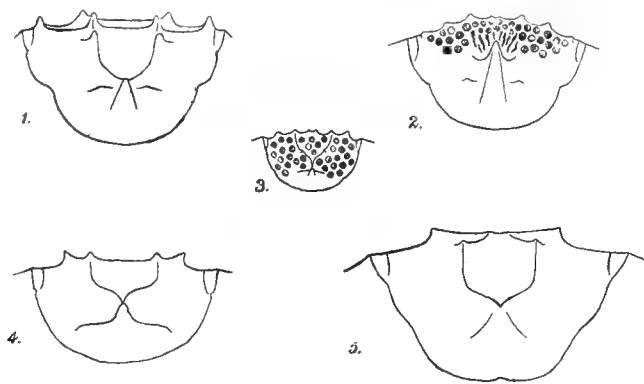


FIG. VIII.

Solenocyclinae ; specific characters in the upper surface of the head $\times 4$.

- | | |
|--|---|
| 1. <i>Malagasalus clypeatus</i> , Gravely. | 4. <i>Eriomomus trichostigmoides</i> , Gravely. |
| 2. <i>Solenocyclus exaratus</i> (Klug). | 5. <i>Eriomomus planiceps</i> (Eshscholtz). |
| 3. <i>Pentalobus punctipectis</i> (Kaup). | |

Genus **SOLENOCYCLUS**, Kaup, 1868a, p. 10.

Incl. *Ciceronius*+*Semicyclus*, Kaup, 1871. Also *Flaminus*+*Vitellinus*, Kuwert.

Type, *Passalus exaratus*, Klug, 1832, p. 173.

Solenocyclus approximatus (Klug).

Passalus approximatus, Klug, 1832, p. 174.

Passalus approximatus, Percheron, 1841, pp. 16-17, pl. lxxvii, fig. 5.

Six specimens from Madagascar, five of them being from Fenerive. Length 26.5-29.0 mm.

The clypeus is hidden. The inner tubercles are smaller than in *Malagasalus clypeatus*, and are situated at a greater distance behind the outer tubercles, which are larger.

Between the outer tubercles is a pair of small and more or less closely approximated (sometimes fused) secondary marginal tubercles, and another such tubercle is situated immediately on the outer side of each. The tubercles situated immediately on the inner side of the fronto-vertical suture are somewhat larger than the two pairs of marginal tubercles last referred to, and are widely separated from them, but they are less pronounced than in *Malagassalus clypeatus*. Coarse punctures are scattered all along the sides of the pronotum. The metasternum is practically hairless. In all other respects the present species resembles the preceding one.

***Solenocyclus morbillosus* (Klug).**

Passalus morbillosus, Klug, 1832, p. 175.

Passalus morbillosus, Percheron, 1841, pp. 18-19, pl. lxxvii, fig. 6.

Eleven specimens from Madagascar, eight being from Fenerive and one (marked "*Ciceronius antanarivae*, Kuw.") from "Antanarivo" (?=Antananarivo). Also two from Andakana, belonging to M. Guy Babault. Length 20.5-24.0 mm. A smaller but more robust insect than the last.

The pair of secondary marginal tubercles situated next to the outer side of the true outer tubercles is distinctly larger than the pair situated close to the fronto-vertical suture, and is situated much nearer to the latter than to the former, which are much larger than either. The margin is often notched medially, and the notch may be bounded by an additional pair of minute secondary tubercles. The frontal ridges diverge at right angles from the low central tubercle and extend direct to the inner tubercles where they bend more or less abruptly and extend parallel to one another, or slightly converging, to the outer tubercles. The general surface of the head is smooth and glossy.

The pronotum is strongly punctured at the sides, and as a rule more or less all over the dorsal surface also. The median groove is strong and complete; the marginal groove is somewhat widely incomplete in front. The mesosternum is more or less coarsely rugose, especially near the lateral sutures; the scars are ill-defined or absent. The metasternum and abdominal sterna resemble those of *S. approximatus*. The grooves of the elytra are almost uniformly punctured.

***Solenocyclus exaratus* (Klug).**

Fig. VIII, 2.

Passalus exaratus, Klug, 1832, p. 173.

Passalus manouffi, Percheron, 1835, p. 62, pl. iv, fig. 7.

A number of specimens, mostly from Fenerive. Length 28-32 mm.

The outer tubercles, and the three pairs of secondary tubercles on the anterior margin of the head, are all of about equal size and about equidistant from each other, except that the secondary tubercles between the outer tubercles are sometimes weaker than the rest. The central tubercle is very large, with a forwardly directed free apex; the whole surface of the head in front of it is coarsely rugose; the inner tubercles are minute, and are situated close to the base of the central tubercle, and the frontal ridges are absent in front of them.

The pronotum is without strong punctures, except in the lateral parts of the marginal groove and in and beside the scars. Both the marginal and the median grooves are

complete. In other respects this species resembles the preceding one, except that the lateral grooves of the elytra are somewhat more coarsely punctured.

Solenocyclus grayi (Kaup).

Semicyclus grayi, Kaup, 1871, p. 28.

Five specimens from Madagascar, including two from Andakana sent for identification by M. Guy Babault. Length 30·5–36·0 mm.

The head is smooth and glossy except close behind the anterior margin, where there are a few large and more or less coalescent punctures. The outer tubercles, though obtuse, are distinctly larger than in *S. exaratus*, and there are no secondary tubercles between them. The free apex of the central tubercle is much larger than in *S. exaratus*, and there is no trace of frontal ridges or inner tubercles.

There are a few punctures in the scars and marginal groove of the pronotum, the pronotum being otherwise unpunctured. The median groove is not very deeply impressed, and neither it nor the marginal groove are complete in front. Along the lateral margins of the mesosternum there extends a band of hair-bearing punctures, on the inner side of which the scars are more or less clearly recognizable. The anterior intermediate and lateral areas of the metasternum, and the posterior border of the posterior intermediate areas, are covered with somewhat fine hair-bearing punctures; there are no coarse punctures anywhere on the metasternum. The elytra are somewhat hairy at the shoulders. The puncturing of their grooves is more or less obsolete, at least dorsally.

Genus **PENTALOBUS**, Kaup, 1868a, p. 17.

Incl. *Didimus*, Kaup, 1871. Also *Didimoides*+*Eumelosomus*, Kuwert, 1896.

Type, *Passalus barbatus*, Fabricius, 1801, p. 256.

Pentalobus klugi (Kaup).

Leptaulax klugii, Kaup, 1868a, p. 12.

Two specimens from Barombi, Cameroons Interior; one from Abetefi, Ashanti; one from Franceville, French Congo; and several from Gaboon. Length 22·0–25·5 mm.

Each antenna bears three short lamellae. The anterior margin of the head bears five more or less equidistant tubercles. The central and inner tubercles are moderately elevated, and the frontal ridges distinct throughout. The surface of the head is punctured sparsely behind the central tubercle, and somewhat more densely in front. The sides of the pronotum are very broadly and coarsely punctured; the median groove of the pronotum is complete; the marginal groove is incomplete in front. The mesosternum is usually more or less matt with somewhat obscure scars. The anterior intermediate areas of the metasternum are more or less distinctly punctured; the lateral areas are very sharply defined throughout and are enlarged behind; the posterior intermediate areas are smooth and glossy. The abdominal sterna are densely and extensively punctured. The lateral grooves of the elytra are transversely punctured.

Pentalobus sansibaricus (Harold).

Passalus sansibaricus, Harold, 1880, pp. 262-263.

Five specimens from Zanzibar, one from Abyssinia, one from Abetefi, one from Rhombomp (Sierra Leone), a number from Dar-es-Salaam, and six said to come from Bolivia. Length 16.5-27.5 mm.

P. sansibaricus differs from *P. klugi* only in having the antennal lamellae somewhat longer, in having the upper surface of the head thickly punctured more or less all over, in having the mesosternum smooth and polished, with well defined scars, and in having the posterior intermediate areas of the metasternum coarsely punctured. The central plate of the metasternum is lightly and sparsely punctured in small specimens.

Pentalobus punctipectus (Kaup).

Fig. VIII, 3, p. 70.

Leptaulax punctipectus, Kaup, 1868a, p. 11.

One specimen from Gaboon. Length 18 mm.

This species differs from small specimens of the last in having a median pair of secondary marginal tubercles instead of a single median tubercle, and in having the central plate of the metasternum less sparsely covered with stronger punctures.

Pentalobus barbatus (Fabricius).

Passalus barbatus, Fabricius, 1801, p. 256.

A large number of specimens from Abetefi, Ashanti; also a few from Amu, Ashanti; Gaboon; Old Calabar; Aquapim, Guinea; Barombi, Cameroons; and Angola; all 23-29 mm. long. Also one specimen from East Africa, 20 mm. long, and two from Franceville, French Congo, 17-19 mm. long, between which and the larger forms I am unable to find any structural difference.

This species differs from *P. punctipectis* in having five antennal lamellae, all of them very long and slender; and in having the central area of the metasternum unpunctured.

Pentalobus parastictus (Imhoff).

Passalus parastictus, Imhoff, 1843, pp. 171-172.

One specimen from Aquapim, Guinea, and one from Barombi, Cameroons Interior. Length 21-24 mm.

The punctures on the head are somewhat shallow, and the anterior margin of the head is lightly exavate medially, but has no median tubercles. The punctures on the central area of the metasternum are more or less concentrated beside the posterior margin. The transverse punctures of the lateral grooves of the elytra are more or less obsolete in the two outermost of these grooves, and all the grooves except the fifth and sixth tend to unite in a matt depression behind. In other respects this species resembles *P. punctipectis*.

Pentalobus fur (Kuwert).

Didimus duplicatus ab. *fur*, Kuwert, 1898, p. 307.

Three specimens from Abetefi, Ashanti. Length 21-23 mm.

It is possible that this form, which Kuwert regarded as an aberration of *P. duplicatus* (Har.) may be no more than a variety of *P. parastictus*. It differs from the latter only in being without punctures in the posterior angles of the pronotum, in having the punctured area on the central area of the metasternum less strongly marked, in having the punctures of the seventh and eighth grooves of the elytra weaker and less distinctly transverse, and in having the posterior angles of the elytra polished instead of matt. These are much the same characters as those by which Kuwert distinguishes this form from the form which he regards as the typical *duplicatus*, a species which I have not seen.

The above-mentioned species of *Pentalobus* may be distinguished as follows :—

- | | | | | | |
|---|---|--|----|----|---------------------------------|
| 1 | { | The anterior margin of the head with a strong median tubercle | .. | .. | 2. |
| | { | The anterior margin of the head medially concave | .. | .. | 3. |
| 2 | { | The posterior intermediate areas of the metasternum unpunctured | .. | .. | <i>P. klugi</i> , p. 72. |
| | { | The posterior intermediate areas strongly punctured | .. | .. | <i>P. sansibaricus</i> , p. 73. |
| 3 | { | The anterior margin of the head with a strong median concavity bounded by a pair of strong secondary tubercles | .. | .. | 4. |
| | { | The anterior margin of the head with a faint median concavity not bounded by definite tubercles | .. | .. | 5. |
| 4 | { | Antennae each with three moderately stout lamellae | .. | .. | <i>P. punctipectis</i> , p. 73. |
| | { | Antennae each with five long and slender lamellae | .. | .. | <i>P. barbatus</i> , p. 73. |
| 5 | { | Elytral grooves 7-8 strongly marked with transverse punctures, the posterior angles of the elytra matt | .. | .. | <i>P. parastictus</i> , p. 73. |
| | { | Elytral grooves 7-8 more faintly punctured, the posterior angles of the elytra glossy | .. | .. | <i>P. fur</i> , p. 74. |

Genus, **ERIONOMUS**, Kaup, 1868a, pp. 16-17.

Incl. *Calidas*+*Epeus*+*Eriosternus*, Kuwert, 1896.

Type, *Passalus planiceps*, Eschscholtz, 1829, pp. 22-23.

Erionomus palini (Percheron).

Passalus palinii, Percheron 1844, pp. 8-9, pl. cxxxv, fig. 1.

A number of specimens from Abetefi, Ashanti, and two from Gaboon. Length 34.5-38.0 mm.

This species superficially resembles *Pentalobus barbatus*. The antennae have, however, only four lamellae ; the anterior margin of the head is approximately straight in the middle ; the puncturing of the sides of the prothorax is somewhat less extensive ; the lateral areas of the metasternum are hairy ; and the punctures of the lateral grooves of the elytra, though very strong, are not transverse.

Erionomus trichostigmoides n. sp.

Fig. VIII, 4, p. 70.

Two specimens, one from Dar-es-Salaam, and one said to come from Santa Catharina in S. E. Brazil. Length 27.5-29.5 mm.

This species bears a close superficial resemblance to species of the Oriental genus *Trichostigmus* from which, however, it may readily be distinguished by the structure of the mandibles, and of the lateral areas of the metasternum, which resemble those of its African allies.

The antennal lamellae are extremely short. The surface of the head is polished and somewhat rugulose; the frontal area is fully as broad as long, and the inner tubercles are somewhat indistinct. The pronotum is without strong punctures; its grooves resemble those found in other members of the genus. The mesosternum is punctured and hairy in front, and roughened and hairy behind, with a small smooth and hairless area in the middle. The metasternum is punctured and hairy, except in the central and posterior parts of the central area. The punctures in the grooves of the elytra are more or less obsolete, but the eighth to tenth ribs are covered with small hair-bearing punctures.

Erionomus alterego (Kuwert).*Eriosternus alterego*, Kuwert, 1898, p. 138.

Two specimens from Abetefi, Ashanti. Length 29-31 mm.

The antennal lamellae are very short. The anterior margin of the head bears a more or less distinct median pair of marginal tubercles, the outer tubercles are somewhat small, and the secondary tubercles on the outer side of them are broadly truncate. The pronotum resembles that of *E. trichostigmoides*, except that the marginal grooves are more strongly punctured. The smooth and hairless central areas of the mesosternum and metasternum are much larger, though the punctures on the latter plate are stronger where they occur. The elytra are hairless except at the shoulders; their dorsal grooves are scarcely, their lateral grooves distinctly but not transversely, punctured.

Erionomus planiceps (Eschscholtz).

Fig. VIII, 5, p. 70.

Passalus planiceps, Eschscholtz, 1829, pp. 22-23.

Three specimens from Guinea and two from Abetefi, Ashanti. Length 38.0-41.5 mm.

In this species the outer tubercles are directed upwards instead of forwards, and appear in consequence to be situated a little behind the anterior margin of the head, beneath which, however, dissection shows the true clypeus to be hidden as usual. The marginal grooves of the pronotum are not strongly punctured. The posterior intermediate areas of the metasternum bear a posterior marginal band of fine close punctures, the rest of these areas being smooth much as in *E. alterego*, which the present species also resembles in all other respects.

The above-mentioned species of *Erionomus* may be distinguished as follows:—

- | | | | | | |
|-----|--|----|----|---------------------------|----|
| 1 { | Each antenna with four long slender lamellae | .. | .. | <i>E. palini</i> , p. 74. | |
| | Each antenna with three short stout lamellae | .. | .. | .. | 2- |

- | | | | | |
|---|---|---|-------------------------------------|----|
| 2 | { | The sides of the elytra covered throughout with hair-bearing punctures | <i>E. trichostigmoides</i> , p. 75. | 3. |
| | | The sides of the elytra hairless except at the shoulders | | |
| 3 | { | The outer tubercles situated as usual on the anterior margin of the head and directed forwards | <i>E. alterego</i> , p. 75. | |
| | | The outer tubercles situated slightly behind the anterior margin of the head and directed upwards | <i>E. planiceps</i> , p. 75. | |

Sub-family *MACROLININAE*.

As defined above (pp. 12-13) this sub-family includes the Macrolininae, Pleurariinae, Aceraiinae, Gnaphalocneminae and Tarquiniinae of my "Account of the Oriental Passalidae." When that account was written only the Indian and Burmese genera and species were adequately represented in the Indian Museum collection. Before it was published I was able to revise to some extent, in the light of a hurried study of the collections in London, Berlin and Hamburg, my ideas regarding the forms from further east; but the arrangement of these forms there suggested is, I believe, capable of considerable improvement, as indicated in the present paper.

The symmetrical genus *Macrolinus* has here been placed next to the genus *Pleurarius*, which seems to replace it in the Indian Peninsula, *i.e.*, before, instead of after, all Oriental genera containing asymmetrical species.

Kuwert's *Heterochilus wallacei* has been removed from the genus *Aceraius* to the genus *Ophrygonius*, where it has been put next to *O. birmanicus* and *O. singapurae*, which it resembles much more closely than it does any species of *Aceraius*. To permit of this change the genera *Ophrygonius* and *Aceraius* have been redefined, greater importance being attached to the character of the mandibles than to that of the elytra; with the result that *Aceraius minor* and *aequidens* of my previous paper have also to be transferred to *Ophrygonius*. The remaining species of *Aceraius* can then be arranged in a single series leading up from forms allied to *minor* and *aequidens* to *grandis* and *occulidens*, which appear to be the most highly specialized members of the genus.

Parapelopides, *Trapezochilus*, *Gnaphalocnemis*, *Pelopides*¹ and *Plesthenus*² are entirely Oriental or Celebean. They resemble the Oriental forms dealt with above in that,

¹ Kuwert placed two species, *schraderi* and *gravidus*, in this genus (1898, p. 322). Zang, who had not seen either of them (1905 *a*, p. 316) pointed out the improbability of their being congeneric (1905 *b*, p. 227), and suggested that the former should be regarded as the type of the genus, presumably on account of its probable relationship with the remaining genus of Kuwert's group Pelopinae. The material in the Van de Poll collection tends to confirm my opinion (1914 *c*, p. 201, footnote 2) that *schraderi* actually belongs to the genus *Protomocoelus*; if, therefore, this species is to be regarded as the type of the genus *Pelopides* this name, having priority over *Protomocoelus*, will probably have to replace it: but there is little hope of settling the identity of *schraderi* with certainty without reference to Kuwert's type. I do not think, however, that Zang's suggestion should be accepted; for Kuwert, in his first definition of *Pelopides* (1896, p. 229), gives only Mindanao as its locality, and this is the locality of *gravidus*, not of *schraderi*. Moreover *gravidus* was known to him before *schraderi*, as it alone is mentioned in his 1891 list, being placed there in the genus *Pelops* (= *Protomocoelus*). *P. gravidus* and not *schraderi* should therefore, I think, be regarded as the type. It is represented in the Van de Poll collection by specimens which appear to have been named by Kuwert himself, and there seems to be no longer any doubt as to its identity.

² Boisduval's *lottinii*, and Kaup's *quadricornis* are, it is true, recorded from "New Holland." But it is quite uncertain whether *lottinii* is a *Plesthenus* at all (Kaup, 1868 *a*, p. 26, and 1871, p. 40; Blackburn, 1900, pp. 207-208);

whenever asymmetry occurs in the mandibles, the dentition is reduced chiefly on the right side.

The distinctive characters of the first four of these genera do not appear to me to have more than specific significance, and I propose to unite them under the name *Pelopides*. The fifth genus, *Plesthenus*, seems to be distinct. It is possible (see below, p. 121) that these genera may have been derived from *Tiberioides*, but as this is by no means certain I have not placed *Tiberioides* beside them, but have left it next to the symmetrical species of *Episphenus*.

Pharochilus, *Episphenoides*, *Mastochilus*, *Analaches* and *Cetejus* may likewise be united, the scars on the mentum, with the aid of which they have hitherto been defined, being variable and not sharply distinctive. The somewhat large genus resulting from this union is, however, composed of four more or less distinct groups of species, for which four of the above names may be retained in a subgeneric capacity. Thus *Pharochilus* may be defined so as to include only large Australian species with extremely short antennal lamellae and more or less extensive matt lateral borders to the mentum. And *Episphenoides* may advantageously, I think, be re-united with the very few known species of *Mastochilus*, and may then be defined so as to include the remaining large symmetrical species. *Analaches* and *Cetejus* are very difficult to separate from *Mastochilus* on structural grounds, but contain species of a much smaller size, many of which are distinctly asymmetrical. *Analaches* contains somewhat larger and flatter species than *Cetejus* with distinctly longer antennal lamellae. According to Heller, who has examined Zang's material (1910, pp. 14 and 21), the upper edge of the left mandible is toothed near the base, and this is in agreement with my observations on the few species before me. This tooth is sometimes, however, situated so near to the base as to be hidden beneath the anterior angles of the head. This is so, for instance, in Stoliczka's *australiensis*, which Heller places in the genus *Cetejus*, in spite of its flattened form and long antennal lamellae, but which dissection shows to be an *Analaches*.

Mastochilus (*s. lat.*) appears to represent the simpler stock from which the remaining genera, all more highly specialized, have been derived. All these other genera are found mainly in the islands east of Celebes, and whenever their dentition is reduced this occurs most markedly on the left side, instead of on the right as in Oriental groups (see pl. I).

Kaupioloides, *Hyperplesthenus*, *Aurelius*, *Labienus* and *Kaupiolus* all have symmetrical mandibles with complete dentition. In the most highly specialized species the elytra are united, and in all of them the intermediate and lateral areas of the metasternum are fused, a fusion which is closely associated with the union of the elytra, tending to follow it in the other groups of Passalidae in which it occurs. Probably, therefore, these genera are losing, if they have not already lost, the power (or at least the habit), of flight, the wings doubtless becoming more efficient stridulatory structures at the same time. None of these genera are very large, and they may advantageously be united under the name *Labienus*.

and in Kaup's original description of *quadricornis* (*loc. cit.*) the only locality referred to is that of the type of *lottinii*, a locality which he has quoted in his monograph, perhaps inadvertently, as that of *quadricornis*. Even if the type of *quadricornis* should prove, on re-examination, to be labelled "New Holland" I should still doubt the validity of the record, in view of the extreme improbability of any such highly specialized species, with Oriental rather than Papuan affinities, occurring there.

Protomocoelus resembles *Labiensus* in having the lateral and intermediate areas of the metasternum fused, though so far as I know the elytra are never united ; but it has the dentition reduced, especially on the left side. It is probably allied to the asymmetrical forms of *Mastochilus* through the more primitive species of *Labiensus* (i.e., *trigonophorus* and *inaequalis*) but does not appear to be allied to the higher forms of the latter genus.

Gonatas, with which the imperfectly separated *Omegarius* (?) and *Tatius* of which I have not seen a specimen) may be united, also tends to have the dentition reduced, especially on the left side

Pseudepisphenus and *Tarquinius* form the last line of descent from *Mastochilus* (s. lat.). They are so unlike superficially that it seems best to retain both genera in the absence of other forms throwing light upon them. Concerning their relationship see Gravely, 1914c, pp. 328-329.

The genera of *Macrolininae* may now be redefined thus :—

- | | | | |
|---|---|---|-----------------------------|
| 1 | { | The supra-orbital and supra-occipital ridges discontinuous ; insects always symmetrical ; the mentum always with primary but without secondary scars | <i>Macrolinus</i> , p. 80. |
| | | The supra-orbital and supra-occipital ridges continuous, the latter sometimes produced outwards behind the former in asymmetrical species without scars of any kind on the mentum | 2. |
| 2 | { | The mentum without scars : the outer side of the mandibles angulate at the base or not at all | 3. |
| | | The mentum with scars ; or, the outer side of the mandibles angulate opposite the anterior lower tooth | 7. |
| 3 | { | Only three lamellae recognizable when the antenna is furled ; the mentum strongly grooved in the middle line from front to back | <i>Pleurarius</i> , p. 84. |
| | | More than three lamellae recognizable when the antenna is furled ; the mentum at most with an incomplete median groove anteriorly | 4. |
| 4 | { | The inner tubercles separated by a space $\frac{1}{3}$ – $\frac{1}{2}$ as long as that separating the outer tubercles | <i>Tiberioides</i> , p. 84. |
| | | The inner tubercles separated by a space $\frac{2}{3}$ –1 times as long as that separating the outer tubercles | 5. |
| 5 | { | The left outer tubercle acute and little or no larger than the right ; or, much larger and curved inwards, with its extremity rounded rather than truncate and never angular on the outer side in front. The dentition complete in symmetrical species ; the lowest terminal tooth always present on both sides ; the right anterior lower tooth smaller than the left in the more highly asymmetrical species. The sides of the elytra hairless. | <i>Episphenus</i> , p. 85. |
| | | The left outer tubercle larger than the right, directed more or less inwards, truncate distally, the outer angle of truncation distinct, forming a more or less forwardly directed apex to the tubercle ; or, the sides of the elytra hairy. The dentition complete, or both the lowest terminal and anterior lower teeth reduced | 6. |

- 6 { The dentition complete in unworn specimens on both mandibles ;
the mandibles in most species symmetrical ; the elytra often
hairless except at the shoulders *Ophrygonius*, p. 86.
- 6 { The lowest terminal and anterior lower teeth of the right
mandible absent, or represented only by very minute
denticles ; the anterior lower tooth of the left mandible very
large ; the elytra more or less extensively hairy at the sides *Aceraius*, p. 89.
- 7 { The dentition of the left mandible not more reduced than that
of the right and the right outer tubercle at least as large as
the left ; the mentum without primary scars ; the secondary
scars very large, more or less completely cutting off the
median from the lateral pieces, usually more or less linear ;
the lateral and intermediate areas of the metasternum never
fused 8.
- 7 { Not as above ; the dentition of the right mandible never more
reduced than that of the left 9.
- 8 { The anterior margin of the labrum with a (frequently indistinct)
tooth near the middle ; all the elytral grooves deeply
impressed throughout, at least the lateral ones strongly
punctured ; the pronotal scars hairless ; at least one of the
outer tubercles more or less complex, or truncate with an
additional tubercle between itself and the anterior angle of
the same side of the head (Oriental forms) *Pelopides*, p. 93.
- 8 { The anterior margin of the labrum not toothed ; some at least
of the elytral grooves feebly impressed and more or less
obsolete behind, none of them at all strongly punctured ; the
pronotal scars more or less hairy ; the outer tubercles acute
or truncate, but never complex or associated with secondary
tubercles (Celebean forms) *Plesthenus*, p. 96.
- 9 { The mentum with well developed primary scars ; the lateral
and intermediate areas of the metasternum distinct *Mastochilus*, p. 97.
- 9 { The mentum without definite primary scars ; or, the lateral and
intermediate areas of the metasternum fused 10.
- 10 { The lateral and intermediate areas of the metasternum fused 11.
- 10 { The lateral and intermediate areas of the metasternum not
fused 12.
- 11 { The dentition of both mandibles complete, normal ; mandibles
more or less symmetrical *Labienus*, p. 103.
- 11 { The dentition of both mandibles reduced—especially that of
the left one ; the anterior lower tooth (when present) widely
separated from the middle lower tooth, and partially fused
with the lowest terminal tooth *Protomococlus*, p. 107.

¹ The fusion is less obvious than in the American forms where it occurs, as the greater part at least of the posterior intermediate areas are hairless and either smooth or coarsely punctured, while the areas on the outer side and in front of them are very hairy and densely but somewhat finely punctured.

- | | | | | |
|----|---|--|----------------------------------|-----|
| 12 | { | The mandibles angulate on the outer side close to the base or not at all ; at most a weak groove extending from this angle to the upper margin | <i>Gonatas</i> , p. 108. | 13. |
| | | The mandibles angulate on the outer side about opposite the anterior lower tooth ; a strong groove extending from this angle to the dorsal margin | | |
| 13 | { | The inner tubercles situated behind the anterior margin of the head ; the outer tubercles asymmetrical | <i>Pseudepisphenus</i> , p. 111. | |
| | | The inner tubercles situated on the anterior margin of the head, giving the insect a <i>Leptaulax</i> -like appearance ; the outer tubercles symmetrical | <i>Tarquinius</i> , p. 111. | |

Genus **MACROLINUS**, Kaup, 1868a, p. 18.

Type, *Passalus latipennis*, Percheron, 1841, pp. 8-9, pl. lxxiii, fig. 3.

Macrolinus andamanensis (Stoliczka).

Basilianus andamanensis, Stoliczka, 1873, pp. 160-161.

Macrolinus andamanensis, Gravely, 1914c, p. 242, pl. xiii, figs. 41-41a.

Ten specimens from the Andamans, where Mr. Kemp recently collected two at Port Blair. Length 32.8-36.5 mm.

Macrolinus sikkimensis (Stoliczka).

Basilianus sikkimensis, Stoliczka, 1873c, pp. 161-162.

Macrolinus sikkimensis, Gravely, 1914c, pp. 243-244, pl. xiii, figs. 42-42a.

Nine specimens from the Darjiling District (Tukvar, also specimens recently collected by myself at Pashok, ca. 2,000 ft.), Assam (Margharita) and the Naga Hills, 2,000-5,000 ft.



FIG. IX.

Macrolinus spp. ; specific characters in the upper surface of the head $\times 4$.

1. *M. obesus*, Gravely.

2. *M. depressus*, Gravely.

M. Vitalis de Salvaza has submitted for examination a specimen from Xieng Khaoung, Tonkin, belonging to the sub-species *tavoyanus*, Gravely. Length 27.3-32.0 mm.

Macrolinus rotundifrons, Kaup.

Macrolinus rotundifrons, Kaup, 1874, pp. 44-45.

Macrolinus rotundifrons, Gravely, 1914c, pp. 244-245, pl. xiii, fig. 43.

Four specimens from Ceylon, one being from Belihul-Oya. Length 27.0-28.5 mm.

Macrolinus obesus, n. sp.

Fig. IX, 1.

Four specimens from Ceylon, three being from Belihul-Oya. Length 29.4-33.4 mm.

The antennal lamellae are very short and stout, even more so than in *M. rotundifrons*, the first three being scarcely twice as long as thick, and scarcely more than half as long as the last three. The ridges and tubercles of the head resemble those of *M. rotundifrons*, but the general surface is less extensively punctured and rugose.

The pronotum is at most sparsely punctured in the anterior angles and in and near the scars. The marginal grooves are widely discontinuous in front and somewhat less widely behind; they are very narrow and are unpunctured except at their anterior ends, which are slightly enlarged and directed a little backwards from the anterior margin. The median groove is very fine, and is incomplete in front. The sides and angles are lightly rounded.

The scutellum is smooth and glossy. The mesothoracic epimera are smooth and glossy antero-dorsally, punctured and glossy below and behind this, then unpunctured and matt, and finally smooth and glossy along the oblique ventral margin. The mesosternum is glossy throughout, but is sometimes indistinctly punctured in the more or less rudimentary scars.

The intermediate and lateral areas of the metasternum are fused and are densely punctured. They are hairy except on the greater part of the space corresponding to the posterior intermediate areas, where the punctures are specially coarse. The abdominal scars are strongly and extensively, but somewhat finely, punctured. The elytra are united; they are lightly convex between the shoulders, short in proportion to their length and lightly convex at the sides, being distinctly broader behind than in front; the grooves are strongly and uniformly punctured, about as strongly as are the lateral grooves of *M. rotundifrons* or the dorsal ones of *M. crenatipennis*.

Macrolinus batesi, Kuwert.

Macrolinus batesi, Kuwert, 1898, p. 187.

Four specimens from Perak, Malay Peninsula, and large numbers from Mana-Riang, Renau, Palembang, Sumatra, 3,000 ft. and from Bng. Proepoe, Pad. Bovenland (=interior of Padang), Sumatra, ca. 1,600 ft.. Mr. Holman-Hunt has sent specimens for examination from the Selangor-Pahang boundary, ca. 3,000 ft., Malay Peninsula; and M. Guy Babault from Medan, Sumatra. Length 25-30 mm.

In my "Account of the Oriental Passalidae" *M. batesi* was regarded as identical with *M. latipennis*. The specimens which I now refer to the former are distinguished by the relative shortness of the second antennal lamella, whose apex does not fall in line with the apices of the first and third lamellae when the antennae are furled; by the small unpunctured frontal area; by the more or less distinctly shouldered outer tubercles; by the large inner tubercles with strongly concave instead of straight or convex connecting ridge; by the narrow marginal grooves of the pronotum, which are hairless except below the scars; by the matt but entirely unpunctured mesosternal scars; and by the coarser puncturing of the lateral grooves of the elytra.

Macrolinus depressus, n. sp.

Fig. IX, 2.

One specimen from Java, 33 mm. long. Closely allied to *M. batesi*, but larger and proportionally flatter. The outer tubercles are strongly shouldered. The pronotum is unpunctured except in the small round hairless scars, and between these and the posterior

halves of the sides, where it is densely hairy. The posterior intermediate areas of the metasternum and the dorsal grooves of the elytra are unpunctured.

Macrolinus latipennis (Percheron).

Passalus latipennis, Percheron, 1841, pp. 8-9, pl. lxxiii, fig. 3.

Macrolinus latipennis, Gravely, 1914c, pp. 245-246, pl. xiii, figs. 45-46.

One specimen from P.Oelak Tanding; two from Hili Madjedja, N. Nias; one each from Bedagei Interior, ca. 600 ft. and Bng. Proepoe, Padang Interior, 1,600 ft., Sumatra; one from Tengger Mountain and several from Buitenzorg, Java; two from Mt. Marapok, Dent Province, Borneo; and one from Mt. Kina-Balu, Borneo, as well as a few without definite locality records. Length 22.5-25.2 mm.

Macrolinus sulciperfectus, Kuwert.

Macrolinus sulciperfectus, Kuwert, 1898, p. 184.

One specimen from Toli-Toli, N. Celebes, 26.7 mm. long.

Macrolinus duivenbodei, Kaup.

Macrolinus duivenbodei, Kaup, 1868 a, p. 19; 1871, p. 43, pl. iv, fig. 6.

Four specimens from Celebes, three being from Menado and one from Loewoe. Length 26-28 mm.

The first two antennal lamellae are more or less distinctly shorter than the remaining four; but all six lamellae are slenderer than in the Ceylonese species *waterhousei* & *rotundifrons* associated by Kaup (1871) in this respect with the present species.

Macrolinus urus, Heller.

Macrolinus urus, Heller, 1898, pp. 23-24, pl. i, fig. 26.

Numerous specimens from Bua-Kraeng, 5,000 ft., S. Celebes. Length 35.4-41.5 mm.

The first three antennal lamellae are much shorter than the last three.

Although the elytra are united in most specimens¹ the lateral and intermediate areas of the metasternum are distinct. This is also the case in *Pleurarius brachyphyllus*, from the Indian Peninsula,² a species in which the elytra are concave between the shoulders and the wings show little or no trace of reduction. The elytra of the present species are convex between the shoulders and the wings or always reduced, being intermediate in form between those of *Pleurarius brachyphyllus* and those of *Macrolinus obesus*.

The key given to the identification of the different species of *Macrolinus*, on pp. 323-24 of my "Account of the Oriental Passalidae" requires considerable modification for the species which I have now seen for the first time to be included in their proper places. It may be emended as follows:—

- | | | |
|-----|--|-----|
| 1 { | The frontal ridges complete and well developed, the inner | |
| | tubercles more or less distinct | 2. |
| 1 { | The inner tubercles, and the anterior part or whole of the | |
| | frontal ridges, obsolete; species confined to Celebes | 13. |

¹ In several they are separate, and show no signs of ever having been united.

² See Gravely, 1915, p. 496.

- | | | | |
|----|---|--|-----------------------------------|
| 2 | { | The six antennal lamellae stout and as a rule not very long, the first three usually very short; species from the Indian Empire, Indo-China, (?) Siam and Ceylon | 3. |
| | | The six antennal lamellae long and slender; species from the Malay Peninsula, Sunda Islands, Philippines and Celebes | 9. |
| 3 | { | The ridge joining the inner tubercles separated from the anterior margin of the head throughout its whole length by a more or less concave surface; species from the Indian Empire, Indo-China and (?) Siam | 4. |
| | | The ridge joining the inner tubercles closely approximated to the anterior margin of the head either in the middle or throughout; species from Ceylon | 6. |
| 4 | { | The lateral grooves of the elytra narrow, their punctures normal | 5. |
| | | The lateral grooves of the elytra broad, their punctures transversely linear <i>M. sikkimensis</i> , p. 80. | |
| 5 | { | The outer tubercles slender in profile, truncate; the ridge joining the inner tubercles concave | <i>M. nicobaricus</i> , Gravelly. |
| | | The outer tubercles stouter and distinctly bifid in profile, the ridge joining the inner tubercles straight | <i>M. andamanensis</i> , p. 80. |
| 6 | { | The ridge between the inner tubercles straight throughout almost its whole length; the anterior angles of the pronotum unpunctured; the antennal lamellae somewhat long | <i>M. waterhousei</i> , Kaup. |
| | | The ridge between the inner tubercles convex, evenly curved throughout; the anterior angles of the pronotum strongly punctured; the antennal lamellae short | 7. |
| 7 | { | The lateral grooves of the elytra almost as broad as the intervening ridges, their punctures very coarse indeed | <i>M. crenatipennis</i> , Kuwert. |
| | | The lateral grooves of the elytra much narrower than the intervening ridges | 8. |
| 8 | { | The elytra separate, parallel-sided, with finely punctured grooves | <i>M. rotundifrons</i> , p. 80. |
| | | The elytra united, more ovate, with coarsely punctured grooves | <i>M. obesus</i> , p. 80. |
| 9 | { | The frontal area small and unpunctured; the inner tubercles large and connected by a strongly concave ridge; the marginal grooves of the pronotum hairless in the anterior angles | 10. |
| | | The frontal area large and punctured all over; the inner tubercles small, and connected by a ridge which is straight as a whole and situated immediately above the anterior margin of the head, and may have a more or less angular median convexity; the marginal grooves of the pronotum hairless only in their anterior terminal enlargements | 11. |
| 10 | { | The anterior angles of the pronotum strongly and extensively punctured; the pronotal scars with a few small hairs | <i>M. batesi</i> , p. 81. |
| | | The anterior angles of the pronotum with not more than one or two punctures; the pronotal scars thickly hairy | <i>M. depressus</i> , p. 81. |

- 11 { The third lamella of the antennae not distinctly shorter than the fourth ; the median groove of the pronotum obsolete 12.
 { The third lamella of the antennae distinctly shorter than the fourth ; the median groove of the pronotum distinct, complete *M. sulciperfectus*, p. 82.
- 12 { The tip of the second lamella not reaching the line joining the tips of the first and third lamellae when the antenna is furled *M. weberi*, Kaup.
 { The tips of all six lamellae arranged in a straight line when the antenna is furled *M. latipennis*, p. 82.
- 13 { The apex of the central tubercle acute, directed forwards, somewhat overhanging *M. duivenbodei*, p. 82.
 { The apex of the central tubercle approximately rectangular in profile, directed upwards, not overhanging *M. urus*, p. 82.

Genus **PLEURARIUS**, Kaup, 1868*b*, p. 1.

Type, *Pleurarius pilipes*, Kaup, 1868*b*, pp. 1-2.

Pleurarius brachyphyllus, Stoliczka.

Pleurarius brachyphyllus, Stoliczka, 1873, pp. 152-153.

This species is not represented in the Van de Poll collection.

Since compiling the list of localities in my "Account of the Oriental Passalidae" I have collected specimens in Cochin at Kavalai, *ca.* 1,300-3,000 ft., and between miles 10 and 14 on the State Forest Tramway, 0-300 ft. M. Guy Babault has presented specimens from near Mahé on the Malabar Coast, and from Kodaikanal in the Palni Hills ; he has also sent for examination specimens from Wallardi in Travancore and from the Coorg region.

It is doubtful whether *P. pilipes*, the only other species of the genus described, is really distinct from *P. brachyphyllus*, although the former is supposed to come from Sumatra and not from India (see Gravely, 1914*c*, p. 320).

Genus **TIBERIOIDES**, Gravely, 1913, p. 405.

Type, *Tiberius kuwerti*, Arrow, 1906, p. 446.

Tiberioides kuwerti (Arrow).

Pl. I.

Tiberius kuwerti, Arrow, 1906, p. 446.

Tiberioides kuwerti, Gravely, 1914*c*, pp. 215-216, pl. xi, fig. 14.

Two specimens from Darjiling and one from N. Manipur, 3,000-9,000 ft. Length 38.5-39.5 mm.

Tiberioides borealis (Arrow).

Fig. X.

Chilomazus borealis, Arrow, 1906, pp. 467-468.

One specimen from N. Manipur, 3,000-9,000 ft. Length 38 mm.

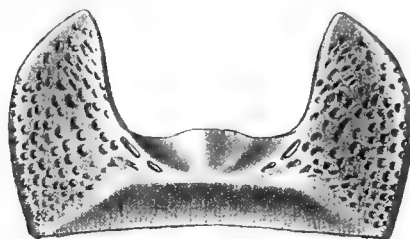


FIG. X.

Tiberioides borealis, Arrow, mentum $\times 8$.The species of *Tiberioides* may be identified thus :—

- | | | | | | |
|---|---|---|---------|-------------------------------|----|
| 1 | { | The lateral grooves of the elytra broad, their punctures trans- | .. .. . | <i>T. kuwertii</i> , p. 84. | |
| | | versely linear | | | |
| 2 | { | The lateral grooves of the elytra narrow, their punctures | .. .. . | .. .. . | 2. |
| | | normal | | | |
| 2 | { | The median part of the mentum without depressions or ridges | .. .. . | <i>T. austeni</i> , Gravelly. | |
| | | The median part of the mentum with a low convexity flanked
by broad shallow depressions close to the middle of the
anterior margin, with a strong transverse ridge behind it .. | | | |

Genus **EPISPHEENUS**, Kaup, 1871, p. 45.Type, *Episphenus moorei*, Kaup, 1871, p. 45.**Episphenus moorei**, Kaup.

Pl. I.

Episphenus moorei, Kaup, 1871, p. 45.*Episphenus moorei* + *pearsoni*, Gravelly, 1914c, pp. 217-218, pl. xi, figs. 16-17.

Eight specimens from Ceylon (Belihul-Oya and Colombo) and one said to be from the Himalayas. Length 30.7-34.2 mm.

Episphenus comptoni (Kaup).

Pl. I.

Aceraius Comptoni, Kaup, 1868a, p. 28.*Episphenus comptoni* + var. *flachi*, Gravelly, 1914c, pp. 218-219, pl. xi, figs. 18-19a.

Eleven specimens from Ceylon, including four from Belihul-Oya and one recently collected by Mr. Kemp on Horton Plains. Length 29.3-42.0 mm.

Episphenus neelgherriensis (Percheron).

Pl. I.

Passalus neelgherriensis, Percheron, 1841, p. 4, pl. lxxvii, fig. 1.*Episphenus neelgherriensis*, Gravely, 1914c, pp. 222-223, pl. xi, figs. 21-21a.

Five specimens from India, one being from Cochin and one from the Madras Presidency. Also specimens presented by Mr. T. Bainbrigge Fletcher from the Nilgiris (Ootacamund), Mysore (Bababudin Hills, 4,500 ft.) and Coorg (Mercara, Santi Koppa and Pollibeta); by M. Guy Babault from Wallardi in Travancore and from the neighbourhood of Trichinopoli and Mahé; and by myself from Cochin (Kavalai, ca. 1,300-3,000). Length 23.3-28.5 mm.

Episphenus indicus (Stoliczka), 1873, pp. 159-160.

Pl. I.

Basilianus indicus, Stoliczka, 1873, pp. 159-160.*Episphenus indicus*, Gravely, 1914c, pp. 220-222, pl. xi, figs. 20-20b.

Eight specimens, one from the Madras Presidency, one from Mercara, Coorg, and six said to be from Assam. Also specimens presented by M. Guy Babault from Wallardi in Travancore, and from near Mahé on the Malabar Coast; by Mr. T. Bainbrigge Fletcher from Santi Koppa in Coorg; and by myself from Kavalai, 1,300-3,000 ft., in Cochin. Length 27.2-36.2 mm.

The species of *Episphenus* may be identified thus:—

- | | | | | |
|---|---|---|------------------------------------|--|
| 1 | { | The anterior margin of the head symmetrical, the anterior margin of the mentum not depressed or grooved .. | <i>E. moorei</i> , p. 85. | |
| | | The anterior margin of the head more or less asymmetrical; the anterior margin of the mentum more or less depressed or grooved | 2. | |
| 2 | { | The anterior margin of the head not very strongly asymmetrical as a rule; the anterior margin of the mentum strongly grooved on either side of a strong median tubercle (occasionally paired) | <i>E. comptoni</i> , p. 85. | |
| | | The anterior margin of the head strongly asymmetrical; the mentum without any strongly marked tubercle | 3. | |
| 3 | { | The anterior angles of the head not prominent | <i>E. neelgherriensis</i> , p. 86. | |
| | | The anterior angles of the head more or less prominent | <i>E. indicus</i> , p. 86. | |

Genus **OPHRYGONIUS**, Zang, 1904a, pp. 697-700.

Incl. *Heterochilus*, Kuwert, 1896 (preoccupied)=*Rhipasapis*, Zang, 1905.

Type, *Ophrygonius quadrifer*, Zang, loc. cit.=*Passalus inaequalis*, Burmeister, 1847, p. 468.

Ophrygonius cantori (Percheron).*Passalus cantori*, Percheron, 1844, pp. 3-4, pl. cxxxiv, fig. 2.*Ophrygonius cantori*, + subspp. *convexifrons* and *dunsiriensis*, Gravely, 1914c, pp. 224-225, pl. xi, figs. 22-22a.

Numerous Himalayan specimens, including three from Tukvar; one specimen from N. Manipur, 3,000-9,000 ft.; and one from the Ruby Mines District of Upper Burma, 5,000-7,000 ft. Specimens have been presented by M. Guy Babault from Kulu (Kandi

and Mandi); by Mr. C. Beeson from Kumaon (Ramgarh, 6,000 ft., under bark of dead oak); by Dr. B. L. Chaudhuri and myself from the Darjiling District (Senchal, *ca.* 8,000 ft., and Pashok 5,500 ft.); by Mr. S. W. Kemp from the Khasi Hills (Shillong 6,400 ft., and Maflong, 5,900 ft.); and by M. Vitalis de Salvaza from Tonkin (Lao Kay).

One specimen labelled "Darjeeling" in the Van de Poll collection is only 28.5 mm. long. All the remaining Himalayan specimens are 30 mm. long or over. The Manipur specimen is 30 mm. long; all the remaining specimens found east of the Darjiling District are 29 mm. long or under. Although, therefore, occasional specimens may transgress the normal limits of the race characteristic of their locality, the validity of difference in size as a distinction between *O. cantori*, s. str., and its sub-species *convexifrons* is confirmed. The form of mentum, on the other hand, described as distinctive of the sub-species *dunsiriensis*, does not appear to be a good character, and although specimens from the Dunsiri valley range from 28 to as much as 31 mm. in length I think that they can best be regarded as belonging to the sub-species *convexifrons*.

***Ophrygonius birmanicus*, Gravelly.**

Ophrygonius birmanicus, Gravelly, 1914c, p. 226, text-fig. 3A.

One specimen from the Ruby Mines District of Upper Burma. Another has been presented by Mr. J. Coggin Brown from Man Lom, Homang, N. Tawngpeng, N. Shan States, Upper Burma, 4,500-5,500 ft.; and others by M. Vitalis de Salvaza from Chapa, Ht. Tonkin, Length 29-33.5 mm.

***Ophrygonius singapurae*, Gravelly.**

Ophrygonius singapurae, Gravelly, 1914c, pp. 226-227, text-fig. 3B.

One specimen from Laos, and two from Mt. Marapok, Dent Province, British North Borneo. Length 30.5-32.2 mm.

In fresh specimens the anterior lower teeth each have their apices produced into a sharp and slender point. The left outer tubercle is distinctly thicker at the base than in the preceding species, but may point more definitely inwards than in the type specimen.

***Ophrygonius wallacei* (Kuwert).**

Heterochilus Wallacei + *crinitus* + *oculitesselatus*, Kuwert, 1898, p. 334.

Aceraius wallacei, Gravelly, 1914c, pp. 228-229, pl. xii, figs. 26-26b.

One specimen from Singapore and a number from Borneo (Mts. Kinabalu and Marapok). Length 33.5-38.0 mm.

The anterior lower tooth on each side is much broader than the lowest terminal. Both are small on the right mandible, but are perfectly distinct in fresh specimens.

***Ophrygonius inaequalis* (Burmeister).**

Pl. I.

Passalus inaequalis, Burmeister, 1847, p. 468.

Ophrygonius inaequalis, Gravelly, 1914c, pp. 227-228, pl. xii, figs. 24-24a.

A number of specimens from Mt. Marapok, Dent Province, British North Borneo; and one from Mt. Kinabalu. Length 23-27 mm.

The punctures in the lateral grooves of the elytra are variable, and I no longer think it at all likely that *oroleius*, Smith, will have to be recognized as a distinct variety.

Ophrygonius aequalis, n. sp.

Fig. XI, 1.

A number of specimens from Chapa, Tonkin, have been sent by M. Vitalis de Salvaza. They vary from 27.3-31.6 mm. in length, and differ from *O. minor* only in their larger size, in having only four antennal lamellae pubescent, in having the upper tooth of both mandibles well developed, in having the left outer tubercle still more nearly identical in

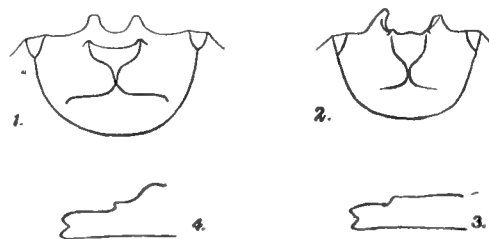


FIG. XI.

1. *Ophrygonius aequalis*, Gravely, part of upper surface of head $\times 4$.

2. *Ophrygonius javanus*, Gravely, part of upper surface of head $\times 4$.

3. *Ophrygonius javanus*, Gravely, left mandible from without, highly magnified.

4. *Aceraius lamellidens*, Gravely, left mandible from without, highly magnified.

size and form with the right, in having the frontal area shorter and distinctly transverse, and in having the punctures on the sides of the pronotum densely clustered in and confined to the scars, instead of very thinly scattered over a slightly more extended area.

Ophrygonius javensis, n. sp.

Fig. XI, 2-3.

One specimen from Boeloe Lawang, Pasoeroean, Java. Length 26 mm. Closely allied to *O. minor*, from which it differs only in having somewhat better developed upper teeth, and in having the punctures and hair on the elytra confined to the ninth and extreme hinder end of the seventh ribs, instead of over the whole of these two ribs.

Ophrygonius aequidens (Gravely).

Aceraius aequidens, Gravely, 1914c, p. 240, text-fig. 4E., p. 234.

Six specimens from Mt. Kinabalu. Length 27-31 mm.

The species of *Ophrygonius* as re-defined in the present paper may be recognized as follows:—

- | | | | |
|---|---|--|-------------------------------|
| 1 | { | The antennal lamellae short and stout; the anterior marginal depressions of the mentum quite small; the sides of the elytra hairy | <i>O. cantori</i> , p. 86. |
| | | The antennal lamellae long and slender; or, the anterior marginal depressions of the mentum very large; or, the sides of the elytra hairy | 2. |
| 2 | { | The antennal lamellae long and slender | 3. |
| | | The antennal lamellae short and stout | 5. |
| 3 | { | The tips of the first two lamellae not falling in line with those of the last four when the antenna is furled; the anterior marginal depressions of the mentum quite small; the sides of the elytra hairless | <i>O. birmanicus</i> , p. 87. |
| | | The tips of all six lamellae forming a straight line when the antenna is furled; or the sides of the elytra hairless. The anterior marginal depressions of the mentum usually large | 4. |

- 4 { The tips of all six lamellae forming a straight line when the antenna is furled; the anterior marginal depressions of the mentum always large and separate; the sides of the elytra hairless *O. singapurae*, p. 87.
- 4 { The tips of the first two lamellae not falling in line with those of the other four when the antenna is furled; the anterior marginal depressions of the mentum very variable, often fused or rudimentary; the sides of the elytra densely hairy in front *O. wallacei*, p. 87.
- 5 { The anterior marginal depressions of the mentum very large; the sides of the elytra hairless *O. inaequalis*, p. 87.
- 5 { The anterior marginal depressions of the mentum more or less rudimentary; the sides of the elytra hairy 6.
- 6 { The upper tooth of both mandibles well developed, more or less rectangular; the frontal area markedly transverse *O. aequalis*, p. 88.
- 6 { The upper tooth of both mandibles rudimentary or at least more obtuse; the frontal area about as long as broad 7.
- 7 { The anterior lower tooth of the left mandible very large, much larger than that of the right mandible 8.
- 7 { The anterior lower tooth of the left mandible scarcely larger than that of the right *O. aequidens*, p. 88.
- 8 { The upper tooth of the left mandible obtuse but moderately large; the seventh ribs of the elytra almost unpunctured *O. javensis*, p. 88.
- 8 { The upper tooth of the left mandible minute; the seventh ribs of the elytra sparsely punctured and hairy throughout *O. minor* (Gravely).

Genus **ACERAIUS**, Kaup, 1868a, pp. 26-27.

Type, *Passalus grandis*, Burmeister, 1847, p. 463.

Aceraius lamellatus n. sp.

Mr. Holman-Hunt has submitted two specimens from the Malay Peninsula (Ulu Gombak), and Mr. Bryant two from Penang, one of each of which has been presented to the Indian Museum collection. Length 23 mm.

This species appears to be allied to various species of the genus *Ophrygonius* on the one hand, and to the genus *Aceraius* on the other. The antennal lamellae and mentum resemble those of *Ophrygonius singapurae*, the former being exceptionally large for so small an insect. The mandibles are of the *Aceraius* type, and resemble those of *A. helferi* except that the convexity of the posterior part of the upper margin is pressed further back from the small upper tooth. In other respects this species resembles *Ophrygonius minor*, except that the eighth ribs of the elytra are punctured instead of (or as well as) the seventh.

Aceraius helferi, Kuwert.

Pl. I.

Aceraius helferi, Kuwert, 1898, pp. 346-347.

Aceraius helferi + *tavoyanus* + *assamensis* + *himalayensis*, Gravely, 1914c, pp. 236-238, pl. xii, figs. 36-39a.

One specimen from Burma and four from Siam, three of the latter being from Renong.

M. Vitalis de Salvaza has presented a fine series of this species from Tonkin (Chapa and Xieng Khouang), and has sent for examination specimens from Ban Tink and Lao

Kay in the same country, and from Cambodia. Mr. J. Coggin Brown has presented specimens from Loi Tawng Kyaw 5,500-7,000 ft., Man Lom, Hamang 4,500-5,500 ft., and between Man Lom and Man Hpat, 4,500-5,500 ft., all in Tawnpeng in the Northern Shan States, Upper Burma. Mr. Holman-Hunt has sent for examination a specimen said to come from the Malay Peninsula (Ulu Gombak) and M. Guy Babault one said to come from Sumatra (Médau). Length 29.3-37.2 mm.

I have already pointed out (1914c, p. 292 footnote) that *A. tavoyanus*, from Southern Tenasserim, is not really distinct from *A. helferi* from further north. The series from Tonkin shows in addition that *A. assamensis*, and *A. himalayensis* are no more than imperfectly separated local races of the same form. Specimens from northerly localities (see pl. i, "*Aceraius*, other spp.") ordinarily have much squarer and less slender left outer tubercles than have specimens from further south. But the shape of this tubercle is not altogether constant in specimens from a single locality; and the gradation of the southern form into the northern seems to be so complete as to render impossible the separation of the species even into two definite races.

***Aceraius alutaceosternus*, Kuwert.**

Aceraius alutaceosternus, Kuwert, 1898, pp. 347-348.

Aceraius alutaceosternus, Gravely, 1914c, p. 236, text-fig. 4E, pl. xii, figs. 34-34a.

One specimen from Perak and one from Borneo. Mr. C. Holman-Hunt has presented a specimen from Bukit Kutu in the Malay Peninsula. Length 35.4-39.5 mm.

The shape of the left outer tubercle of this species is the same as that of the most extreme form found among southern specimens of the preceding, of which it is little more than a local race. The size of the posterior convexity of the upper margin of the left mandible, and the faint median groove on the anterior part of the mentum, appear, however, to afford constant distinctive characters by which it may be recognized.

***Aceraius borneanus*, Kaup.**

Aceraius borneanus, Kaup, 1871, p. 52.

Aceraius borneanus, Gravely, 1914c, pp. 238-239, pl. xii, figs. 25-25b.

One specimen from the Malay Peninsula (Pahang), four from Sumatra (three being from the interior of Bedagei on the east coast, *ca.* 600 ft.), many from North Nias (Hili Madjedja and G. Madjeja), five from Middle Nias (Dyma and Kalim Bungo), one from Java, and many from Borneo (Doesonlanden, Brunei, and Mts. Marapok and Kinabalu). Mr. C. Holman-Hunt has presented a specimen from Ulu Gombak, Malay Peninsula. Length 23.0-29.2 mm.

This species appears to be somewhat rare in the Malay Peninsula and Java, but to be abundant in Sumatra and Borneo.

***Aceraius pilifer* (Percheron).**

Passalus pilifer, Percheron, 1835, pp. 23-24, pl. ii, fig. 2.

Aceraius pilifer, Gravely, 1914c, pp. 235-236, pl. xii, fig. 35.

Numerous specimens from the following places in Java: Tji Bodas, *ca.* 4,000 ft.; Pengalengan, 4,000 ft.; Mt. Tjikorai, 4,000 ft.; Mt. Gede, 4,000 ft.; Telaga Bodas

Garoet Preanger, 4,000-5,000 ft.; G. Tji Salimar, W. Preanger, *ca.* 3,000 ft.; Boeloe Lawang Res. Pasoeroean. Length 27-32 mm.

This species appears to be very common in Java, where it probably replaces the preceding one. It seems to be rare in Sumatra and Borneo. It has not been recorded from the Malay Peninsula.

***Aceraius perakensis*, Kuwert.**

Aceraius perakensis, Kuwert, 1898, p. 308.

Aceraius perakensis + *laevimargo*, Gravelly, 1914c, pp. 229 and 235.

A number of specimens from Mt. Kinabalu. M. Guy Babault has presented a specimen from near Dolok-Baros, Médan, Sumatra. Length 34-40 mm.

A. laevimargo, Zang, appears to be identical with the species which I previously separated as *A. perakensis*.

***Aceraius tricornis*, Zang.**

Aceraius tricornis + *kuwert*, Zang, 1903a, p. 339.

Aceraius tricornis + *kuwert*, Gravelly, 1914c, p. 235, text-fig. 4 B, pl. xi, fig. 31.

Two specimens from Mt. Maropok, and a number from Mt. Kinabalu. Length 46.0-52.5 mm.

The characters by which *A. tricornis* is separated from *A. kuwert* prove to be variable, and the second name must fall.

***Aceraius laniger*, Zang.**

Aceraius laniger, Zang, 1905a, pp. 191-192.

Aceraius laniger, Gravelly, 1914c, p. 234.

Three specimens from Borneo, two being from Mt. Kinabalu. Length 54.0-56.5 mm.

The characters distinguishing this species from the last, small though they are, do not appear to vary.

***Aceraius möschleri*, Kuwert.**

Aceraius möschleri, Kuwert, 1898, p. 344.

Aceraius möschleri, Gravelly, 1914c, pp. 229-230, pl. xii, fig. 33.

Four specimens from Mt. Kinabalu in Borneo. Length 35-37 mm.

***Aceraius illegalis*, Kuwert.**

Aceraius illegalis, Kuwert, 1898, p. 345.

Aceraius illegalis, Gravelly, 1914c, p. 230, pl. xii, figs. 32-32a.

Nine specimens from Borneo (Mts. Kinabalu and Marapok). Length 40-43 mm.

***Aceraius laevicollis* (Illiger).**

Passalus laevicollis, Illiger, 1800, p. 103.

Aceraius laevicollis, Gravelly, 1914c, pp. 230-231, pl. xii, figs. 27-27a.

Many specimens from the Malay Peninsula (Singapore, Larut, Penang, Perak); Sumatra (Bedagei Interior, *ca.* 600 ft.; Tandjong-Djati, Ranau, Palembang, *ca.* 2,000 ft.; S. E. Serdang, E. Coast, *ca.* 1,000 ft.); N. Nias (Hili Madjedja and G. Madjeja); Middle Nias

(Dyma) ; Java ; Borneo (Mts. Marapok and Kinabalu, British N. Borneo, Riam Kanan and Pengaron, Martapoera) ; Bali ; and S. Celebes (Tjamba). Length 30·7–37·3 mm.

Aceraius grandis (Burmeister).

Pl. I.

Passalus grandis, Burmeister, 1847, p. 463.

Aceraius grandis + var. *rectidens* + subsp. *hirsutus*, Gravely, 1914c, pp. 231-233, pl. xii, figs. 28-30.

Specimens of the typical form from Sumatra (Mana-Riang, Renau, Palembang, 2,000-3,000 ft. ; Bng. Proepoe, interior of Padung, ca. 1,600 ft. ; also specimens presented by M. Guy Babault from Médan) ; North Nias (Hili Madjedja and G. Madjeja) ; Middle Nias (Kalim Bungo and Dyma) ; Java (G. Tji Salimar, W. Preanger, \pm 3,000 ft. ; Kawie Mountains, Pasoeroean ; Tji Bodas, ca. 4,000 ft.) and Borneo (Mt. Kinabalu and Brunei). Length 40-55 mm.

Specimens of subspecies *hirsutus*, Kuwert, from Nepal ; Darjiling District (Tukvar) ; Assam (Margherita ; Chandkhira, Sylhet) ; Upper Burma (Cachin Cauri) ; Laos ; Tonkin (Xiang Khouang, Hoabink, Chapa and Napé—all presented by M. Vitalis de Salvaza, who has also submitted one from Ban Tink for examination) and S. Palawan. Length 36·8-49·0 mm.

The examination of the above recorded specimens has shown that southern specimens must all be regarded as belonging to a single race. Neither of the names *rectidens* and *addendus* (see Gravely, 1914c, p. 322 footnote) need, therefore, be retained.

Aceraius occulidens, Zang.

Aceraius occulidens, Zang, 1905a, pp. 190-191.

Aceraius occulidens, Gravely, 1914c, p. 234, text-fig. 4A.

Specimens from the Malay Peninsula have been presented by Mr. Holman-Hunt, who has also submitted one for examination from Gap, 2,700-3,000 ft., on the Selangor-Pahang boundary. Length 45·5 mm.

The species of *Aceraius*, as re-defined in this paper, may be identified as follows :—

- | | | | |
|---|---|---|-------------------------------|
| 1 | { | The upper tooth of the left mandible simple, set in a hollow in front of a convexity of the upper margin, from which it is distinctly separated at base | 2. |
| | | The upper margin without a convexity behind and distinct from the upper tooth ; this margin concave or straight, or else uniformly convex the whole way from the tip of the upper tooth backwards ; or, the upper tooth bifid | 5. |
| 2 | { | The six antennal lamellae exceptionally long and slender | <i>A. lamellatus</i> , p. 89. |
| | | The antennal lamellae short and stout, the first two more or less rudimentary | 3. |
| 3 | { | The posterior part of the tenth and the whole of the eighth ribs of the elytra unpunctured | 4. |
| | | The seventh to tenth ribs of the elytra (inclusive) punctured throughout | <i>A. borneanus</i> , p. 90. |

- 4 { The convexity of the upper margin of the left mandible moderately high; the mentum with no trace of a median groove *A. helferi*, p. 89.
- 4 { The convexity of the upper margin of the left mandible very pronounced; the mentum with a fine groove in front *A. alutaceosternus*, p. 90.
- 5 { The anterior angles of the head more or less obtuse, never prominent 6.
- 5 { The anterior angles of the head sharper, more or less distinctly prominent 9.
- 6 { At most 32 mm. long; usually shorter *A. pilifer*, p. 90.
- 6 { At least 34 mm. long, usually much longer 7.
- 7 { At most 40 mm. long; the right outer tubercle distinct and more or less sharply pointed in unworn specimens, the antennal lamellae and other characters very variable *A. perakensis*, p. 91.
- 7 { At least 43 mm. long; the right outer tubercle more obtuse or absent 8.
- 8 { The right outer tubercle more or less obsolete; the tenth ribs of the elytra hairless and unpunctured throughout *A. tricornis*, p. 91.
- 8 { The right outer tubercle distinct; the tenth ribs of the elytra punctured and hairy anteriorly *A. laniger*, p. 91.
- 9 { The right outer tubercle simple, acute and moderately long 10.
- 9 { The right outer tubercle usually shorter, truncate or rounded; sometimes, however, divided into two separate tubercles of which the outer one or both may be more or less long and acute 11.
- 10 { The anterior angles of the head scarcely prominent; the tip of the right outer tubercle not bent outwards *A. möschleri*, p. 91.
- 10 { The anterior angles of the head distinctly prominent; the tip of the right outer tubercle bent more or less abruptly outwards *A. illegalis*, p. 91.
- 11 { At most 38 mm. long; the anterior angles of the head scarcely more prominent than in *A. illegalis*, somewhat variable *A. laevicollis*, p. 91.
- 11 { Specimens no larger than *A. laevicollis* with the left anterior angle of the head produced into a long slender inwardly curved process; larger ones (which may be as much as 55 mm. in length) with the angles more moderately prominent, the largest closely resembling *A. laevicollis* in form 12.
- 12 { The canthus without any upwardly directed tubercle *A. grandis*, p. 92.
- 12 { A small and stout erect tubercle arising from the dorsal surface of the canthus immediately in front of the eye *A. occulidens*, p. 92.

Genus **PELOPIDES**, Kuwert, 1896, p. 229.

Incl. *Gnaphalocnemis*, Heller, 1900 (= *Eriocnemis*, Kaup, 1868, preoccupied).

Also *Trapezockilus*, Zang, 1905 (= *Phraortes*, Kuwert, 1896, preoccupied) + *Parapelopides*, Zang, 1904a.

Type, *Pelopides gravidus*,¹ Kuwert, 1898, p. 322.

¹ See above, p. 76, footnote 1.

Pelopides symmetricus (Zang).

Pl. I.

Parapelopides symmetricus, Zang, 1904a, pp. 695-697, figs. 1-2.*Parapelopides symmetricus*, Gravely, 1914c, pp. 246-247, text-figs. 6A-B.

Two specimens from Mt. Marapok, and a number from Mt. Kinabalu. Length 37.0-42.7 mm.

Pelopides gravidus Kuwert.

Fig. XII.

Pelopides gravidus, Kuwert, 1898, p. 322.

Five specimens, apparently cotypes, from Davao, Mindanao. Length 43-46 mm.

P. gravidus is to some extent transitional between *P. symmetricus* and *P. simplex*. The anterior lower tooth of the right mandible is distinct when unworn, but is smaller than in *P. symmetricus*. The head has both the outer tubercles broad as in *P. symmetricus*,

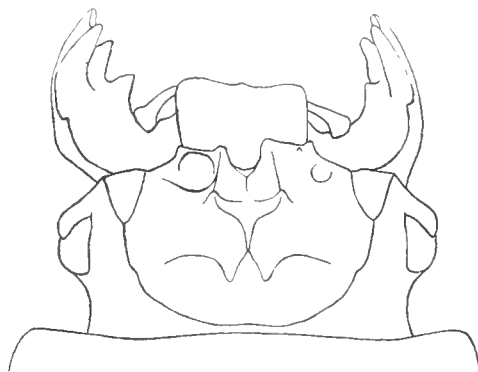


FIG. XII.

Pelopides gravidus, Kuwert; head from above $\times 4$.

but the inner portion of the right one is distinctly more prominent than that of the left, while the left one is flanked by a very deep and the right by a shallower concavity. The elytra are very like those of *P. monticulosus*. In all other respects *P. gravidus* resembles *P. symmetricus*.

Pelopides dorsalis (Kaup).

Pl. I.

Eriocnemis dorsalis, Kaup, 1871, p. 41.*Trapezochilus nobilis*,¹ + *respectabilis*, Gravely, 1914c, pp. 247-248, text-fig. 5 C-E., pl. xiii, fig. 48.

Six specimens from Perak and one from Sumatra; also four from Médan (nr. Dolok-Baros, Sumatra, presented by M. Guy Babault. Length 32.5-40.0 mm. The smaller specimens have the grooves of the elytra more strongly punctured than the larger ones.

Pelopides burmeisteri (Kaup).*Eriocnemis Burmeisteri*, Kaup, 1868a, p. 22.*Gnaphalocnemis burmeisteri*, Gravely, 1914c, p. 249, pl. xiii, fig. 49.

A number of specimens from Sumatra (Mana-Riang and Tandjong-Djati, Renau, Palembang; Bandar, Palembang; Bng. Præpoe, interior of Padang; Kandg. Ampat, Padang Beneden; also two from Médan, presented by M. Guy Babault); two from Java (one being from Tji Solak, Wynkoop's Bay) and six from Borneo (one being from Sintang and three from Sarawak). Length 38-49 mm.

¹ See also Gravely, 1914c, p. 297 (*T. dorsalis*).

Pelopides monticulosus* (Smith).Passalus monticulus*, Smith, 1852, p. 6, pl. i, fig. 1.*Gnaphalocnemis monticulosus*, Gravelly, 1914c, pp. 249-250, pl. xiii, fig. 49a.

Three specimens from Sumatra (two being from Bedagei Interior, *ca.* 600 ft.), and a number from Borneo (Mts. Kinabalu and Marapok). Length 39-45 mm.

***Pelopides tridens* (Wiedemann).**

Pl. 1.

Passalus tridens, Wiedemann, 1823, pp. 109-110.*Gnaphalocnemis tridens*, Gravelly, 1914c, p. 250, pl. xiii, figs. 50-50a.

Nine specimens from Sumatra (Bedagei Interior, *ca.* 600 ft.; Gng. Talang, Padang Interior; Mt. Singalang); many from Java (Telaga Bodas, Garoet, 4,000-5,000 ft.; G. Tji Salimar, *ca.* 3,000 ft.; Tji Bodas, Gng. Gede, *ca.* 4,000 ft., all in Preanger; also Buitenzorg and Tjandiroto); and one said to come from the Key Islands (near New Guinea). Length 46-56 mm.

The species of *Pelopides* may be identified as follows:—

- | | | | | | | | | | |
|---|---|---|----|----|----|----|---------------------------------|--------------------------------|----|
| 1 | { | The anterior lower tooth of the right mandible small but distinct | | | | | | | |
| | | in unworn specimens | .. | .. | .. | .. | .. | .. | 2. |
| | { | The anterior lower tooth of the right mandible absent | .. | .. | .. | .. | .. | .. | 3. |
| | | | | | | | | | |
| 2 | { | The outer tubercles at least approximately symmetrical; the | | | | | | | |
| | | anterior lower tooth of the right mandible larger .. | | | | | | <i>P. symmetricus</i> , p. 94. | |
| | { | The inner angle of the right outer tubercle produced forwards | | | | | | | |
| | | and inwards beyond that of the left; the former acute, the | | | | | | | |
| | | latter obtuse; the anterior lower tooth of the right mandible | | | | | | | |
| | | smaller | .. | .. | .. | .. | .. | <i>P. gravidus</i> , p. 94. | |
| 3 | { | The left outer tubercle consisting of a single, somewhat slender, | | | | | | | |
| | | obliquely truncate process; the right one, of a similar but | | | | | | | |
| | | broad and slightly bifid inner process together with smaller | | | | | | | |
| | | pointed outer and middle processes | .. | .. | .. | .. | <i>P. simplex</i> , (Gravelly). | | |
| | { | Both tubercles consisting of two or three denticles more or less | | | | | | | |
| | | fused together, the tubercle as a whole being very broad | | | | | | | |
| | | on the right or on both sides | .. | .. | .. | .. | .. | 4. | |
| 4 | { | The right and left outer tubercles of equal size, though not | | | | | | | |
| | | always of identical form | .. | .. | .. | .. | <i>P. dorsalis</i> , p. 94. | | |
| | | The right outer tubercle much broader than the left | .. | .. | .. | .. | .. | 5. | |
| 5 | { | The lateral grooves of the elytra all narrow, simply punctured | | | | | <i>P. burmeisteri</i> , p. 94. | | |
| | | Grooves 5-7 of the elytra more or less broad; each containing a | | | | | | | |
| | | polished flattened band, which is marked by a single row of | | | | | | | |
| | | punctures, and defined on either side by a more or less dis- | | | | | | | |
| | | tinct roughened line with which the punctures may be to | | | | | | | |
| | | some extent confluent | .. | .. | .. | .. | .. | 6. | |

- 6 { Grooves 5-7 of elytra somewhat variable in width ; the posterior part of groove 8 rarely wider than the anterior part, never as wide as groove 7 ; insects at most about 45 mm. long .. *P. monticulosus*, p. 95.
- 6 { Grooves 5-7 of elytra always very broad ; the posterior part (and sometimes the whole) of groove 8 like them ; insects at least about 45 mm. long *P. tridens*, p. 95.

Genus **PLESTHENUS**, Kaup, 1871, p. 40.

Type, *Eriocnemis quadricornis*, Kaup, 1868a, p. 26.

Of the four species referred by Kuwert (1898, pp. 324-5) to the genus *Plesthenus* one, *lottini*, Boisduval, probably belongs to an Australian genus,¹ the other three being Celebean (see above, p. 76, footnote 2). Of these three *invitus*, Kuwert, is the most distinct. This species is represented in the Van de Poll collection by perhaps three specimens. Each of them is, however, distinguished by some definite character from the others ; and at least two localities are represented by the three specimens, one of which bears no locality record. It is impossible, therefore, to be certain at present whether the three specimens belong to three separate species or not ; and it will probably be best to describe all under the one specific name, referring at the same time to the individual differences.

The other two species, *quadricornis*, Kaup, and *gelon*, Schaufuss, are together represented by eleven specimens from five localities, two in the north of the island and three in the south. The southern specimens are distinctly larger than the northern, and they have an acuminate or very obliquely truncate right outer tubercle, the left outer tubercle being more or less obsolete ; in the northern specimens, on the other hand, the right outer tubercle tends to be more abruptly truncate, and the left outer tubercle to be more strongly developed, in some instances much more so. Here again it seems impossible to determine with certainty how many species are represented in the material before me, the differences between different forms being in this case undoubtedly correlated with locality. I propose, therefore, to treat all as a single species *quadricornis*, recognizing *gelon* as a more or less distinct southern race. The races seem to be distinguished more definitely by size than by structure.

I am unable to identify any of the specimens before me with either of the species described since Kuwert's work was published (see above p. 9), but it is possible, I think, that these may prove to be no more than varietal forms of *P. quadricornis*.

Plesthenus invitus, Kuwert.

Pl. I.

Plesthenus invitus, Kuwert, 1898, p. 325.

Three specimens, one of which is from Tondano, Minahassa and another from Menado. Both the specimens whose localities are recorded are 45.5 mm. long ; the other specimen is much bigger, being 53 mm. long.

This species differs from *Pelopides burmeisteri*, *monticulosus* and *tridens* only in the generic character mentioned above (p. 79), in having the left anterior lower tooth wholly distinct from the lowest terminal tooth instead of partially fused with it, and in the weaker

¹ Presumably *Mustochilus*.

and more crescentic scars on the mentum. The outer tubercles of the head are practically symmetrical, the right one being slightly broader than the left, at least in the Tondano specimen. In this specimen the space between the inner and outer tubercles is surrounded by fine but distinct ridges, of which the lateral and posterior are straight, and the anterior procurved. In the large specimen the lateral ridges are absent, the anterior one is procurved and the posterior one recurved ; and in the Menado specimen even the anterior and posterior ridges are indistinct.

Plesthenus quadricornis, Kaup.

Pl. I.

Eriocnemis quadricornis, Kaup, 1868a, p. 26.

Plesthenus quadricornis, 1871, p. 40, pl. iv, fig. 4.

Four specimens of the northern race, *quadricornis*, s. str. [(see above, p. 96), from Toli-Toli and three from Menado, both in Northern Celebes. One specimen of the southern race, *gelon* (Schaufuss, 1885, pp. 187-188), from Samanga, one from Patunuang, and two from Macassar, all in Southern Celebes. Length of the northern race 49-53 mm. Length of the southern race 55-60 mm.

P. quadricornis differs from *P. invitus* only in having the right outer tubercle somewhat longer, and sometimes more obliquely truncate or even acuminate, and in having the left outer tubercle smaller and acuminate or obsolete. In the Toli-Toli specimens the left outer tubercle is an acutely pointed process, scarcely shorter than the inner side of the somewhat obliquely truncate right outer tubercle. In the Menado specimens it is much shorter, the apex being rectangular or even obtuse. This is the case in the specimens from Samanga and Patunuang also ; but in these the right outer tubercle is somewhat slenderer and more obliquely truncate ; in size, moreover, these specimens resemble those from Macassar and not the preceding. In the Macassar specimens the left outer tubercle is scarcely recognizable, and the right outer tubercle is acuminate.

The two above described species of *Plesthenus* may be identified thus :—

{	The outer tubercles approximately symmetrical, both of them	
	truncate	<i>P. invitus</i> , p. 96.
{	The outer tubercles asymmetrical, the right one much larger	
	than the left and truncate, except when the latter is obsolete,	
	in which case it may be acuminate ; the left one never	
	truncate	<i>P. quadricornis</i> , p. 97.

Genus **MASTOCHILUS**, Kaup, 1868a, pp. 19-20, corrected 1868b, p. 31.

Type, *Passalus polyphyllus*, MacLeay, 1826, p. 439.

This genus, as pointed out above (p. 77), may be divided into four more or less distinct sub-genera :—

1 {	The mentum laterally with a narrow depressed matt border, or	
	more extensively matt ; large Australian forms with very	
	short antennal lamellae ; always symmetrical	<i>Pharochilus</i> , ¹ p. 98.
2 {	The mentum uniformly glossy in fresh specimens ; the antennal	
	lamellae much longer ; or not Australian	

¹ Kaup, 1868a, pp. 20-21. Type, *Passalus dilatatus*, Dalman.

- { Robust symmetrical insects at least 34 mm. long; almost all
 Australian¹ *Mastochilus*, s. str., p. 100.
 2 { Smaller insects—never more than 33 mm. long; almost all
 from New Guinea and the neighbouring islands;² often
 asymmetrical 3.
 3 { The upper margin of the left mandible strongly angulate;
 the antennal lamellae longer and the body more flattened .. *Analaches*,³ p. 101.
 The upper margin of the left mandible, behind the upper tooth,
 not or scarcely angulate; the antennal lamellae shorter and
 the body more robust *Cetejus*,⁴ p. 102.

***Mastochilus* (*Pharochilus*) *dilatatus* (Schönherr).**

Passalus dilatatus, Schönherr, 1817, p. 334, appendix, p. 144.

A few specimens from Queensland (Cardwell) and New South Wales (Richmond River and Sidney). Length 31-36 mm.

The inner tubercles are large, somewhat as in *M. quaestionis*, but they are widely separated, the frontal area being always strongly transverse, and not elevated. The general texture of the upper surface of the head resembles that of *M. australasicus*. The more or less confluent and transverse grooves on the mentum are deeply crescentic, being almost equidistant from the anterior and posterior margins near the middle line; and the punctured lateral parts of the mentum have a narrow matt border on the outer side. The elytra resemble those of *M. quaestionis* and *M. australasicus*, except that the punctures are somewhat transverse, especially towards the posterior end, where the ridges between them are apt to be more or less obsolete.

***Mastochilus* (*Pharochilus*) *nitidulus*, MacLeay.**

Pl. I.

Mastochilus nitidulus, MacLeay, 1871, p. 175.

Pharochilus nitidulus, Kuwert, 1898, p. 333.

Two specimens from New England, New South Wales, presented by Mr. H. Schrader. Length 41 mm.

The lateral lobes of the mentum resemble those of *M. dilatatus*. The median part of the mentum resembles that of *M. politus*, which species this one resembles in all other respects.

¹ The only exception known is *M. pectinigera* (Heller) from New Guinea (length 39.5 mm). Concerning the position of *obliquus*, Kirsch, see Heller, 1910, pp. 17-18.

² The only exception known is *Analaches australiensis*, which is apparently found both in Australia and New Guinea (length 25.5-30.0 mm).

³ Kuwert, 1896, p. 230. Type, *Epilaches puberilis*, Kuwert, 1898, p. 337 (see Zang, 1905a, p. 238, footnote; also p. 24).

⁴ Kaup, 1871, p. 53. Type, *Aceraius virginalis*, Kaup, 1868b, p. 5.

Mastochilus (Pharochilus) politus (Burmeister).

Fig. XIII, 1.

Passalus politus, Burmeister, 1847, pp. 465-466.

A number of specimens from Queensland and Victoria, and two from Tasmania (Brighton). Also three presented by Mr. H. Schrader, two being from Tingha and one from the Clarence River, both in New South Wales. Length 30.5-37.0 mm.

The upper surface of the head resembles that of *M. dilatatus*, except that there is a secondary tubercle developed on the upper side of the base of each of the outer tubercles, which consequently appear very high and obliquely truncate in side view. The ridge

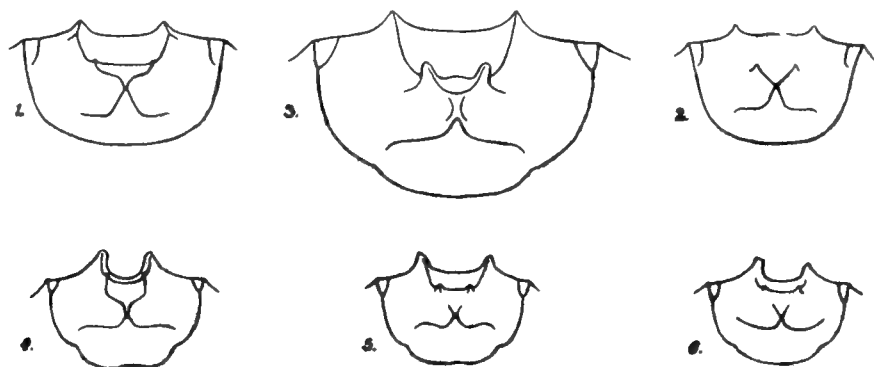


FIG. XIII.

Mastochilus spp., specific characters in the upper surface of the head $\times 4$.

- | | |
|--|---|
| 1. <i>M. (Pharochilus) politus</i> (Burmeister). | 4. <i>M. (Analaches) australiensis</i> (Stoliczka). |
| 2. <i>M. (Pharochilus) punctiger</i> , Gravelly. | 5. <i>M. (Cetejus) grabowskii</i> (Kuwert). |
| 3. <i>M. (s. str.) quaestionis</i> (Kuwert). | 6. <i>M. (Cetejus) peltostictus</i> (Kaup). |

bounding posteriorly the crescentic groove on the mentum is usually more pronounced, and the lateral matt border is very broad and extends round in front on to the inner side of the punctured area. The punctures in the lateral grooves of the elytra, though sometimes irregular, and inclined to be more or less transverse behind, as a rule resemble those of *M. quaestionis* and *australasicus* more closely than they do those of *M. dilatatus*.

Mastochilus (Pharochilus) punctiger, n. sp.

Fig. XIII, 2.

Two specimens from New South Wales. Length 33 mm.

The small triangular frontal area is bounded laterally by high frontal ridges and inner tubercles, somewhat as is *M. quaestionis*, but is not itself elevated. The ridges joining the inner tubercles to each other and to the outer tubercles are absent, a broad transverse flattened rugose band extending between the supraorbital ridges from the inner tubercles to the anterior margin of the head; behind this band the head is smooth and glossy. The mentum is somewhat coarsely and sparsely punctured between the scars, with a more or less triangular, extensive (but sometimes indistinct) depression in front. Its lateral parts are more closely and finely punctured on the inner side, obliquely striate with a more or less smooth matt border on the outer.

The median groove of the pronotum is deeply impressed, but may be incomplete in front; the marginal grooves are coarsely punctured in their anterior extremities, which bend slightly inwards; the remainder of them is very finely punctured, as are also the pronotal scars. The general surface of the pronotum is unpunctured. The scutellum

bears a number of scattered punctures, especially in front. The mesosternum is matt, with a coarsely punctured \wedge -shaped area in front. It is without scars. The posterior intermediate areas of the metasternum are closely and coarsely punctured, with the exception of a band bordering the somewhat narrow and rugose lateral areas. The elytra resemble those of *M. australasicus*.

Mastochilus (s. str.) quaestionis (Kuwert).

Fig. XIII, 3, p. 99.

Episphenoides quaestionis, Kuwert, 1898, p. 327.

A number of specimens from New South Wales, several being from the Richmond River. Length 44-51 mm.

Easily distinguished from all other known species by its large inner tubercles, which are situated very close to one another and to the central tubercle, the whole of the small triangular concave frontal area being strongly elevated. The small central part of the mentum is usually marked with a pair of more or less confluent shallow transverse grooves a little behind, and a small depression in the middle of, the anterior margin; but either or both of these may be faint or absent; or one may be so strongly developed as to obliterate the other; strong ridges, however, are never present. The lateral parts of the mentum, in front of the primary scars, are glossy, punctured and hairy throughout. The pronotum has no median groove; its scars are punctured. The elytra are more coarsely punctured at the sides than above.

Mastochilus (s. str.) australasicus (Percheron).

Pl. I.

Passalus australasicus, Percheron, 1841, pp. 67, pl. lxxvii, fig. 2.

A number of specimens from Queensland, New South Wales (Richmond River) and Victoria (Melbourne); also a series said to come from Dodinga in Halmaheira;¹ also specimens presented by Mr. H. Schrader from Tingha and New England, New South Wales. Length 37-48 mm.

The small inner tubercles are situated nearly half as far from the outer tubercles as the latter are from each other, and almost directly behind them. The ridge uniting the inner tubercles is often absent. When present it may lie close in front of the frontal ridges, or some distance in front of them. The frontal area, which may thus be almost non-existent or of considerable size, is smooth and glossy; the area between it and the anterior margin of the head is very rough. The pronotum, mentum and elytra resemble those of *M. quaestionis*.

Mastochilus (s. str.) polyphyllus (MacLeay).

Passalus polyphyllus, MacLeay, 1826, p. 439.

Several specimens from Queensland and New South Wales (Sidney); also one said to come from Dodinga in Halmaheira.¹ Length 34-40 mm.

The central and inner tubercles are more widely separated than in the preceding species; and the frontal ridges, instead of running direct between the two, diverge either from an

¹ Probably part of a series from Australia which has been wrongly labelled.

anterior prolongation of the central tubercle or at very acute angle, and curve first outwards and then a little forwards, with the result that the frontal area appears markedly transverse. The ridge joining the inner tubercles together is present, but there are no ridges in front of these tubercles. The mentum is glossy throughout, and bears a small but deeply impressed V- or U-shaped groove in the middle in front; only the lateral parts are punctured. The pronotum resembles that of *P. punctiger*, the median groove being very strongly developed. The dorsal grooves of the elytra are imperfectly, the lateral ones strongly but not very coarsely, punctured.

***Mastochilus (Analaches) australiensis* (Stoliczka).**

Fig. XIII, 4, p. 99.

Cetejus australiensis, Stoliczka, 1873, pp. 157-158 (continuation of footnote to p. 156).

A number of specimens from Queensland, one from New South Wales and one from New Guinea (Stephansort, Astrolabe Bay). Length 25.5-30.0 mm. The smallest and flattest species known from Australia, also the only one with asymmetrical outer tubercles.

All six antennal lamellae are extremely long and slender. The upper tooth of both mandibles is obsolete, and the denticle behind it, though well developed, is more or less hidden beneath the ends of the supra-orbital ridges; from this denticle a slight ridge extends downwards to the outer angle of the mandible, which is produced into an acute and outwardly (almost forwardly) directed tooth. The outer tubercles are very large, the left one slightly more so than the right; the gap between them is semi-circular. The inner tubercles are situated at their base; the frontal area is about twice as broad as long. The general surface of the upper side of the head is more or less strongly punctured. The secondary scars on the mentum are transverse and matt; with the middle of the anterior margin they enclose more or less completely a small triangular glossy area.

The pronotum is more or less sparsely covered at the sides with large punctures, which tend to concentrate in and around the scars. Its marginal grooves are punctured throughout and are scarcely bent inwards at their anterior ends. The median groove is more or less obsolete. The dorsal grooves of the elytra are finely punctured; the lateral ones are much broader than the ridges between them, and the transverse ridges between their enlarged matt punctures are more or less obsolete.

***Mastochilus (Analaches) puberilis* (Kuwert).**

Epilaches pubarilis, Kuwert, 1898, p. 337.¹

One specimen from Milne Bay, British New Guinea, and one presented by the British Museum, also from New Guinea. Length 31-33 mm.

The mandibles are not angulate externally, and the denticle near the base of the upper margin is not covered by the anterior angles of the head. The outer tubercles resemble those of *M. australiensis*, but the inner ones are situated a considerable distance behind them. The frontal area is smaller and more triangular. The pronotum is somewhat indistinctly punctured in the scars and marginal grooves; except for this it is unpunctured; the median groove may be somewhat stronger. The dorsal grooves of the elytra are

¹ First mentioned in Kuwert's 1891 list, where the name is spelt *puberilis* as above.

unpunctured; the lateral ones are strongly punctured. In other respects this species resembles *M. australiensis*.

Mastochilus (Cetejus) grabowskii (Kuwert).

Fig. XIII, 5, p. 99.

Cetejus grabowskii, Kuwert, 1898, p. 330.

Three specimens from Humboldt Bay, New Guinea.¹ Length 28.5-29.0 mm. A stouter insect than *M. australiensis* or *M. puberilis*, with shorter antennal lamellae.

The mandibles are not angulate externally, and there is no denticle exposed on the upper margin behind the rudimentary upper tooth. The upper surface of the head resembles that of *M. puberilis*, except that the outer tubercles are more outwardly directed, that the central and inner tubercles are more widely separated, and that the frontal ridges are more or less incomplete between them. The secondary scars on the mentum are represented by a more or less broken transverse groove a little behind the anterior margin. The scars, anterior angles, and marginal grooves of the pronotum are coarsely punctured; the median groove is very strong. All the grooves of the elytra are somewhat coarsely punctured.

Mastochilus (Cetejus) sodalis (Kaup).

Aceraius sodalis, Kaup, 1868a, pp. 29-30: and 1868b, p. 5.

A number of specimens from Ternate and Batjan, one of the latter being from Labuan; also one from Taruna, Gt. Sangir, 2,000 ft. Length 24.0-25.8 mm.

This species closely resembles the last, but is smaller and therefore less perceptibly asymmetrical; it has a somewhat shorter frontal area, and has the groove formed by the secondary scars on the mentum deep and unbroken.

Mastochilus (Cetejus) peltostictus (Kaup).

Fig. XIII, 6, p. 99; also pl. I.

Aceraius peltostictus, Kaup, 1868b, pp. 5-6.

Two specimens from Ceram and many from New Guinea, one of the latter being from Stephansort. Length 22.5-26.3.

The outer tubercles are strongly asymmetrical, the left one being slightly longer than the right, broad and truncate instead of slender and pointed, and more inwardly directed. The groove representing the secondary scars on the mentum is more strongly arched away from the anterior margin than in *M. sodalis*, and the grooves of the elytra are more finely punctured, especially the dorsal ones. In other respects *M. peltostictus* resembles *M. sodalis*.

¹ The two specimens which I recorded from Stephansort (1914c, p. 334), though compared with named specimens in Berlin, do not agree with Kuwert's description of the present species, and are apparently *M. peltostictus*, Kaup.

The above-mentioned species of *Mastochilus* may be grouped into four sub-genera as indicated above (pp. 97-98), and may be distinguished from one another thus:—

I. Sub-genus **PHAROCHILUS**, Kaup.

- | | | | |
|---|---|--|------------------------------|
| 1 | { | The median part of the mentum with at most two or three punctures | 2. |
| | | The median part of the mentum strongly punctured throughout | <i>M. punctiger</i> , p. 99. |
| 2 | { | The lateral lobes of the mentum with a more or less narrow matt border on the outer side | 3. |
| | | The lateral lobes of the mentum broadly matt on the outer side | <i>M. politus</i> , p. 99. |
| 3 | { | The ridges of the elytra obsolete in the extreme posterior angles | <i>M. dilatatus</i> , p. 98. |
| | | The ridges of the elytra normal | <i>M. nitidulus</i> , p. 98. |

II. Sub-genus **MASTOCHILUS**, s. str.

- | | | | |
|---|---|---|-----------------------------------|
| 1 | { | The frontal area small, almost equilaterally triangular, raised above the general surface of the head | <i>M. quaestionis</i> , p. 100. |
| | | The frontal area not raised above the general surface of the head, usually much broader than long | 2. |
| 2 | { | The secondary scars very variable in development; when present always extending inwards from the ends of the anterior margin of the median part of the mentum | <i>M. australasicus</i> , p. 100. |
| | | The secondary scars always developed as a pair of fine grooves defining a small and more or less equilaterally triangular shield in the middle of the anterior margin | <i>M. polyphyllus</i> , p. 100. |

III. Sub-genus **ANALACHES**, Kuwert.

- | | | | |
|---|---|--|-----------------------------------|
| 1 | { | The lateral grooves of the elytra much broader than the ridges between them; the transverse ridges between their enlarged matt punctures more or less obsolete | <i>M. australiensis</i> , p. 101. |
| | | The lateral grooves of the elytra narrow and strongly punctured | <i>M. puberilis</i> , p. 101. |

IV. Sub-genus **CETEJUS**, Kaup.

- | | | | |
|---|---|--|----------------------------------|
| 1 | { | The left outer tubercle pointed, directed forwards or a little outwards | 2. |
| | | The left outer tubercle truncate, directed inwards | <i>M. peltostictus</i> , p. 102. |
| 2 | { | The secondary scars on the mentum represented by a more or less broken transverse groove a little behind the anterior margin | <i>M. grabowskii</i> , p. 102. |
| | | The groove formed by the secondary scars on the mentum deep and unbroken | <i>M. sodalis</i> , p. 102. |

Genus **LABIENUS**, Kaup, 1871, p. 39.

Incl. *Aurelius*, Kuwert, 1896; *Hyperplesthenus*, Kuwert, 1898; *Kaupioloides*, Gravelly, 1913; *Kaupiolus*, Zang, 1903b (= *Vellejus*, Kaup, 1871, preoccupied).

Type, *Eriocnemis ptox*, Kaup, 1868a, p. 25.

Labienus inaequalis, n. sp.

Figs. XIV, 1 and XV. 1.

Two specimens from Hattam, Arfak, Dutch New Guinea. Length 37.7-38.7 mm.

This species is closely allied to *L. trigonophorus*, from which it differs in the following particulars only. The anterior margin of the labrum is more strongly concave. The primary scars on the mentum are much smaller, and the secondary ones much larger, the latter almost meeting in the middle line immediately in front of the posterior margin. The general surface of the head is less rugose than in *L. trigonophorus*, and the left outer tubercle is much larger and more definitely directed inwards; the frontal ridges are obsolete in front.

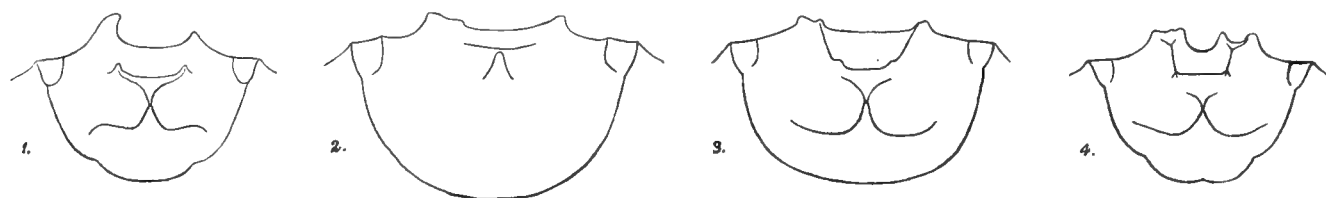


FIG. XIV.

Labienus spp. ; specific characters in the upper surface of the head $\times 4$.

- | | |
|------------------------------------|-------------------------------------|
| 1. <i>L. inaequalis</i> , Gravely. | 3. <i>L. ptoxoides</i> , Gravely. |
| 2. <i>L. dohrni</i> (Kuwert). | 4. <i>L. compergus</i> (Boisduval). |

of the inner tubercles. The anterior angles of the prothorax are somewhat more obtuse; the median groove is complete. The posterior intermediate areas of the metasternum are almost unpunctured as well as being hairless; the lateral areas are thickly punctured and hairy as in *L. trigonophorus*, their surface being on the same level as that of the intermediate areas, an abrupt change of level occurring only where they touch the central area. Neither in *L. trigonophorus* nor in *L. inaequalis* are the elytra united.

Labienus dohrni (Kuwert).

Fig. XIV, 2; also pl. 1.

Aurelius dohrni, Kuwert, 1898, p. 326.

Four specimens from Dutch New Guinea, three being from Hattam, Arfak, and one from Kapaur. Length 42-47 mm.

This species is easily recognized by the small free forwardly directed apex of the central tubercle and the absence of inner tubercles. The frontal and parietal ridges are obsolete or absent. The outer tubercles may be simple and symmetrical, or the left one may be more or less distinctly double; the anterior margin of the head is usually more or less rough between them, this rough area being separated from the rest of the head by a fine ridge or groove.

The pronotum is much broader behind than in front; its median groove is indistinct; it is without punctures except in the posterior angles (including the true scars, though other unpunctured depressions may be present near them), which are densely hairy and punctured. The scutellum bears two longitudinal lines of fine punctures. The mesothoracic episterna are punctured except in the posterior angles. The mesosternum is smooth and polished; its scars are distinct, but very small and less close to the margin than usual. The metasternum resembles that of *L. trigonophorus*. The grooves of the elytra are deep but unpunctured.

Labienus ptoxoides, n. sp.

Figs. XIV, 3 and XV, 2.

Two specimens, one from Andai and the other from Mt. Arfak, both in New Guinea. Length 44-46 mm.

This species is allied to *L. gracilis* and *L. ptox*. The antennae resemble those of *L. ptox*, the first two lamellae being quite short and the remaining four very long. The secondary scars of the mentum are straight, and extend to the posterior margin. The head closely

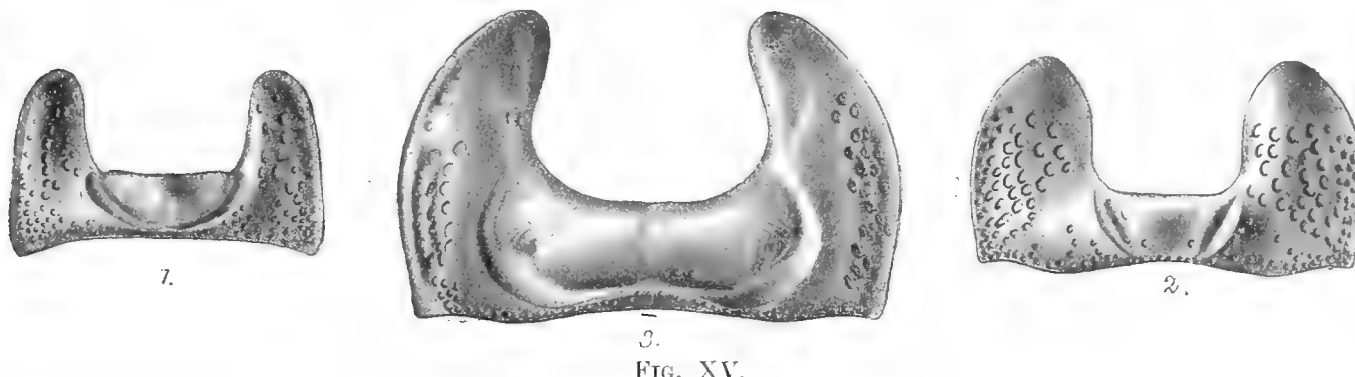


FIG. XV.

Labienus spp. ; mentum $\times 8$.1. *L. inaequalis*, Gravelly.2. *L. ptoxoides*, Gravelly.3. *L. ptox*, Kaup.

resembles that of both *L. gracilis* and *L. ptox*, especially the latter. The pronotum resembles that of *L. ptox*, the scars being more densely hairy and punctured than in *L. gracilis*. In all other respects the present insect resembles both species.

Labienus ptox, Kaup.

Fig. XV, 3.

Eriocnemis ptox, Kaup, 1868a, p. 25.*Labienus ptox*, Kaup, 1871, p. 39.

Numerous specimens from New Guinea (Stephansort, Bongu, Milne Bay and Roan Islands), Aru (Ureiuning and Wamma Dobbo) and Waigeu. Also one said to come from Borneo and three from Sumatra. Length 48-58 mm.

This species differs from the last only in its larger size and in having the scars on the mentum strongly arched instead of straight.

Labienus compergus (Boisduval).

Fig. XIV, 4 ; also pl. 1.

Passalus compergus, Boisduval, 1835, pp. 244-246.*Vellejus compergus*, Kaup, 1871, p. 36.

Several specimens from New Guinea (Milne Bay ; Stephansort, Astrolabe Bay ; Andai ; Kapaur ; and Hattam, Arfak) and one from Waigeu. Length 32-36 mm.

The antennae resemble those of the majority of species belonging to the genus. The right outer tubercle is more or less distinctly double. The left outer tubercle may be similar, or may be composed of three more or less distinct processes. The pronotal scars are unpunctured and hairless. The mesosternal scars are variable. The posterior intermediate areas of the metasternum are unpunctured. All the grooves of the elytra

especially the lateral ones, are distinctly punctured. In other respects this species resembles *L. ptox*.

***Labienus moluccanus* (Percheron).**

Passalus moluccanus, Percheron, 1835, pp. 31-33, pl. ii, fig. 7.

Numerous specimens from Ceram (Roemasosa-Pasama in the central part, Wahaai in the north, Elpapoeti Bay in the south, Honitetoe in the West), Limtoe in Nusa Laut, Saparua, Hitu and Leitimor in Amboina, Batjan. Length 42-52 mm.

This species differs from the last only in having the frontal ridges more or less obsolete behind the inner tubercles, in having the two processes of each of the outer tubercles less distinct (much as in *L. ptox* and *ptoxoides*) and in having the elytra united in the middle line.

***Labienus gigas* (Kaup).**

Pl. 1.

Eriocnemis gigas, Kaup, 1868a, p. 23.

Seven specimens from Batjan, including five from Laboean, one from Halmaheira one from Ternate, and two without locality records. Length 56-64 mm. I am unable to distinguish between *L. gigas* from Ternate and *L. crassus* from Batjan.

The elytra are united as in *L. moluccanus*, which the present species resembles in all respects, except in having each of the outer tubercles composed of three more or less distinct blunt processes, and in having the posterior intermediate areas of the metasternum, and as a rule the pronotal scars, punctured, though not hairy.

The species of *Labienus* known to me may be identified thus:—

1	{	The secondary scars on the mentum convergent behind, curved or straight, not very widely separated as a whole	2.
		The secondary scars on the mentum strongly arched outwards, very widely separated as a whole	8.
2	{	The outer tubercles simple, conical; the grooves of the elytra punctured	3.
		Not as above	4.
3	{	The left outer tubercle scarcely longer than the right; the mentum with primary scars	<i>L. trigonophorus</i> (Zang) ¹ .
		The left outer tubercle much longer than the right; the mentum without primary scars	<i>L. inaequalis</i> , p. 104.
4	{	The central tubercle free apically	<i>L. dohrni</i> , p. 104.
		The central tubercle not free	5.
5	{	The outer tubercles long and simply truncate	<i>L. glaber</i> (Gravely) ¹ .
		The outer tubercles much shorter, not simply truncate	6.
6	{	Both outer tubercles composed of two blunt denticles; the scars of the pronotum without punctures or hair	<i>L. impar</i> (Kuwert) ¹ .
		The inner denticle of the right outer tubercle more or less obsolete; the scars of the pronotum with hair-bearing punctures	7.

¹ See Gravely, 1913, for figures of these species.

- | | | | | |
|----|---|---|---|-----|
| 7 | { | The antennal lamellae normal | <i>L. gracilis</i> , Heller. ¹ | |
| | | The first two antennal lamellae very short, the remaining four exceptionally long | <i>L. ptoxoides</i> , p. 105. | |
| 8 | { | The first two antennal lamellae very short, the remaining four exceptionally long | <i>L. ptox</i> , p. 105. | |
| | | The antennal lamellae normal | | 9. |
| 9 | { | The elytra separate; insects of moderate size | <i>L. compergus</i> , p. 105. | |
| | | The elytra united; insects of large size | | 10. |
| 10 | { | The outer tubercles much narrower than the space between them, each being composed of two more or less distinct blunt processes only; the posterior intermediate areas of the metasternum smooth | <i>L. moluccanus</i> , p. 106. | |
| | | The outer tubercles at least as broad as the space between them, each including an additional blunt process on the inner side of, and some distance from, the two found in <i>L. moluccensis</i> ; the posterior intermediate areas of the metasternum coarsely punctured | <i>L. gigas</i> , p. 106. | |

Genus **PROTOMOCOELUS**, Zang, 1905b, p. 154.

=*Pelops*, Kaup, 1871, preoccupied.

Type, *Passalus australis*, Boisduval, 1835, pp. 246-247, pl. vi, fig. 21.

Protomocoelus australis (Boisduval).

Pl. I.

Passalus australis, Boisduval, 1835, pp. 246-247, pl. vi, fig. 21.

Pelops australis, Kaup, 1871, p. 38.

Five specimens from the Solomon Islands (including one from San Cristoval and one from Bougainville), three from New Britain, many from New Guinea (Milne Bay) Stephansort and Isola Yule), and several from Waigeu, Aru (Wamma Dobbo and Ureiuning) and Ceram. Also one specimen said to come from Australia. Length 30-47 mm. The Solomon Islands specimens (except the one from Bougainville, which is only 35 mm. long), and the specimen labelled Australia, are much the largest, none of the others exceeding 37 mm. in length. Apart from the Bougainville specimen the smallest of the Solomon Islands specimens is 41 mm. long. I am unable, however, to find any constant structural difference between the Solomon Islands specimens and the others, and am consequently unable to recognize *P. solomonis* (Kaup) as distinct. *P. australis* is somewhat variable, and the validity of Kuwert's species may be doubted.²

Protomocoelus australis is probably allied more closely to *Labienus inaequalis* than to any other species yet described. It differs from it, however, in the structure of the mandibles (see above, pp. 78 and 79); in the broader and often more widely separated, but very variable,

¹ See Gravelly, 1913, for figures of this species.

² *Passalus impressicollis*, Boheman 1858, p. 40, cannot belong, as supposed by Kuwert, to the present genus, for its outer tubercles are equal and obtuse instead of unequal and acute. It comes from Sydney, and not from Menado as stated by Kuwert; it is said by Boheman to be allied to *Mastochilus polyphyllus*, and doubtless belongs to the same genus.

scars on the mentum ; in having the frontal ridges more or less obsolete behind instead of in front of the inner tubercles ; in the deep concavity between the outer tubercle and the anterior end of the supraorbital ridge of the left or of both sides of the head ; in having the right outer tubercle about as long as the left although more slender ; in having no distinct median groove on the pronotum ; in usually having punctures on the posterior intermediate areas of the metasternum ; and in having the dorsal grooves of the elytra as distinctly punctured as the lateral ones. The elytra are not united in either species.

Genus **GONATAS**, Kaup, 1871, p. 50.

Incl. *Omegarius*+ ? *Tatius*, Kuwert, 1896, p. 229.

Type, *Passalus naviculator*, Percheron, 1844, pp. 1-2, pl. cxxxiv, fig. 1.

Gonatas minimus (Kuwert).

Pl. I.

Omegarius minimus, Kuwert, 1898, p. 313.

Omegarius minimus, Gravely, 1913, pp. 110-111, text-fig. 3A.

Three specimens from New Brittain, of which two are from Herbertshöhe ; one said to be from Australia and one without locality record. Length 20-25 mm.

Gonatas pumilio, Kaup.

Aceraius pumilio, Kaup, 1868b, p. 6.

Gonatas pumilio, Kaup, 1871, p. 50.

Omegarius pumilio, Gravely, 1913, p. 112, text-fig. 3B.

Several specimens from New Guinea (Torres Straits, Fly River, Kapaur), Waigeu Amboina (Leitimor), and Ceram (Honiteto in the western, Wahaai in the northern, and



FIG. XVI.

Gonatas spp. ; mentum $\times 8$.

1. *G. cetioides*, Zang.

2. *G. tenimbrensis*, Gravely.

3. *G. carolinensis*, Gravely.

4. *G. minor*, Gravely.

5. *G. naviculator* (Percheron).

Roemasosal-Pasania in the central parts of the island). Also one specimen said to come from the Sulu Islands. Length 18.5-23.0 mm.

Gonatas cetioides, Zang.

Fig. XVI, 1.

Gonatas cetioides, Zang, 1905a, p. 316.

One specimen from Herbertshöhe, New Brittain. Length 25 mm.

The antennae resemble those of *G. minimus*, the mandibles those of *G. pumilio*. The posterior margin of the mentum is very lightly curved as in both species, but the lateral

forwardly directed parts of the scars are much more, and the other parts less, deeply impressed than in either. The lateral areas of the metasternum are somewhat smoother and the pronotum and elytra somewhat more convex than in either.

Gonatas schellongi, Kuwert.

Pl. I.

Gonatas schellongi, Kuwert, 1898, p. 314.

Numerous specimens from New Guinea (Stephansort, Milne Bay, Humboldt Bay, Torres Straits), Kei Islands, and New Brittain (Herbertshöhe). Length 28-32 mm.

The antennal lamellae are longer than in the two preceding species, and the posterior margin of the mentum is more strongly curved, the scars consequently forming a W- rather than a ω -shaped figure. The left mandible is as broad as the right and scarcely if at all longer; its anterior lower tooth is less distinct than in *G. minimus*, but more distinct than in other species of the genus. The form of the outer tubercles varies slightly, and *G. tridentatus*, Kuwert, is unlikely, I think, to prove distinct; *G. differens*, *albertisi*, *major* and *novaebritanniae* will perhaps also prove to be identical with the present species. The lateral areas of the metasternum are punctured and hairy. The dorsal grooves of the elytra are less distinctly punctured than are the lateral ones.

Gonatas germari, Kaup.

Aceraius germari, Kaup, 1868a, pp. 30-31.

Gonatas germari, Kaup, 1871, p. 51.

Gonatas germari, Gravelly, 1914c, pp. 250-251, pl. xiii, figs. 47-47a.

Numerous specimens from Ternate and Batjan (Labuan), five from Halmaheira (Dodinga) and Great Banda, one from Morty Island near Halmaheira, one from the Kei Islands, and one said to be from Australia. Also one from New Guinea (Dorey) and four from Buru (Wakollo in the central part of the island, and Ilat on the east coast) all of much larger size. Length, excluding the Dorey and Buru specimens, 23.5-26.5 mm.; length of Dorey specimens 29.0 mm.; length of Buru specimens 31.0-32.5 mm.

The antennae and mentum resemble those of *G. schellongi*. The left mandible is distinctly longer than the right, and its anterior lower tooth is more or less obsolete. The lateral areas of the metasternum are punctured and more or less hairy. The difference between the distinctness of the punctures in the dorsal and lateral grooves of the elytra is less great than in *G. schellongi*.

Gonatas tenimbrensis, n. sp.

Fig. XVI, 2.

Five specimens from Tenimber (or Timor Laut), four being from Jandema. Length 25.5-27.0.

Closely allied to the preceding species, from which it differs only in having still less or no trace of the left anterior lower tooth, in having antennae with shorter lamellae like those of *G. minimus* and *G. cetioides*, and in having the lateral areas of the metasternum unpunctured and hairless. The scars on the mentum are deeply impressed throughout.

Gonatas carolinensis, n. sp.

Fig. XVI, 3, p. 108.

Three specimens from the Caroline Islands. Length 22.4-23.2 mm.

This species differs from the last only in its smaller size, slightly longer antennal lamellae, and more even mentum, the scars being less deeply impressed, especially medially.

Gonatas minor, n. sp.

Fig. XVI, 4, p. 108.

Four specimens from Mefor ("Mafor") and one from Run ("Roon") Islands. Length 21.3-22.2.

The antennae are very long as in *G. germari*. The difference in length between the right and left mandibles is somewhat greater in *G. minor* and in the next species than in any other. The mentum resembles that of *G. germari*; its scars are less deeply impressed than in *G. tenimbrensis*, but more deeply impressed than in *G. carolinensis*. The lateral areas of the metasternum are smooth and hairless. In other respects the present species resembles *G. germari* and *G. naviculator*.

Gonatas naviculator (Percheron).

Fig. XVI, 5, p. 108; pl. I.

Passalus naviculator, Percheron, 1844, pp. 1-2, pl. cxxxiv, fig. 1.*Gonatas naviculator*, Kaup, 1871, pp. 50-51.

Numerous specimens from Saparua Island, several from Ceram (Kairatoe in the Western and Roemasosal-Pasama in the central part of the island) and Buano, one from Nusa-Laut, and one said to come from New Guinea. Length 23.0-28.5 mm.

G. naviculator can be distinguished from all other species of the genus known to me by the strongly and as a rule abruptly curved posterior margin of the mentum, though this character is not always so clearly marked in specimens from the mainland of Ceram as in those from the neighbouring islands. The antennal lamellae are comparatively short and stout as in *G. tenimbrensis*, etc. The mandibles resemble those of *G. minor*. The outer tubercles are somewhat slenderer than in *G. germari*, which the present species resembles in other respects.

The above-mentioned species of *Gonatas* may be identified thus:—

- | | | | |
|---|---|---|-------------------------------|
| 1 | { | The posterior margin of the mentum very lightly curved ; | |
| | | the scars more or less ω -shaped | 2. |
| | { | The posterior margin of the mentum more strongly curved ; | |
| | | the scars more or less W-shaped | 4. |
| 2 | { | The dentition of both mandibles complete and well developed | <i>G. minimus</i> , p. 108. |
| | | The anterior lower tooth of the left mandible rudimentary or absent | 3. |
| 3 | { | The antennal lamellae very slender ; the scars on the mentum distinctly ω -shaped | <i>G. pumilio</i> , p. 108. |
| | | The antennal lamellae stouter ; the scars on the mentum intermediate between the ω and W form, very deeply impressed laterally | <i>G. cetioides</i> , p. 108. |

- | | | | | |
|---|---|---|----------------------------------|----|
| 4 | { | The left anterior lower tooth small but distinct; the left mandible of about the same size as the right | <i>G. schellongi</i> , p. 109. | |
| | | The left anterior lower tooth more or less rudimentary; the left mandible more or less distinctly longer and slenderer than the right | | 5. |
| 5 | { | The posterior margin of the mentum moderately strongly arched | | 6. |
| | | The posterior margin of the mentum very strongly arched; the antennal lamellae somewhat short and stout; the lateral areas of the metasternum somewhat rough and hairy .. | <i>G. naviculator</i> , p. 110. | |
| 6 | { | The lateral areas of the metasternum more or less rough and hairy; the antennal lamellae very long and slender .. | <i>G. germari</i> , p. 109. | |
| | | The lateral areas of the metasternum smooth and hairless | | 7. |
| 7 | { | The antennal lamellae somewhat short and stout; the scars on the mentum very deeply impressed | <i>G. tenumbrensis</i> , p. 109. | |
| | | The antennal lamellae longer and slenderer; the scars on the mentum less deeply impressed | | 8. |
| 8 | { | The left mandible and the antennal lamellae moderately long and slender; the scars on the mentum very lightly impressed, especially near the middle line | <i>G. carolinensis</i> , p. 110. | |
| | | The left mandible and the antennal lamellae somewhat longer and slenderer; the scars on the mentum normal | <i>G. minor</i> , p. 110. | |

Genus **PSEUDEPISPHENUS**, Gravelly, 1914c, p. 327.

Type, *Pseudepisphenus perplexus*, Gravelly, 1914c, pp. 327-328, text-fig. 8, A-B.

Pseudepisphenus perplexus, Gravelly.

Pl. I.

Pseudepisphenus perplexus, Gravelly, 1914c, pp. 327-328, text-fig. 8, A-B.

One specimen from Snow Mts., 4,000-6,000 ft., Dutch New Guinea, presented by the British Museum. Length 29.5 mm.

Genus **TARQUINIUS**, Kuwert, 1896, p. 227.

Type, *Tarquinius paradoxus*, Kuwert, 1898, p. 279; Gravelly, 1914c, pp. 178 & 327, text-fig. 8, C.-D. (see pl. I).

Subfamily **LEPTAULACINAE**.

The genera of Leptaulacinae may be separated thus:—

- | | |
|--|--------------------------------|
| The sides of the elytra hairy | <i>Trichostigmus</i> , p. 112. |
| The sides of the elytra hairless | <i>Leptaulax</i> , p. 112. |

Genus **TRICHOSTIGMUS**, Kaup, 1871, p. 31.

Trichostigmus ursulus, (Schaufuss).

Leptaulax ursulus, Schaufuss, 1885, p. 187.

A number of specimens from S. Celebes (Lompa-Battau, 3,000 ft., and Tjamba).
Length 16.0-19.5 mm.

Trichostigmus ursulus resembles *Leptaulax bicolor*, except in the generic character and in having the sides of the pronotum more sparsely punctured in the neighbourhood of the scars and not at all in the anterior angles.

Trichostigmus thoreyi, Kaup.

Trichostigmus thoreyi, Kaup, 1868a, pp. 13-14.

A single specimen presented by Mr. C. F. Baker from Imugin, N. Viscaya, Phillipines.
Length 16.7 mm.

T. thoreyi differs from the preceding and only other known species of the genus only in the structure of the pronotum.

The species of *Trichostigmus* may be distinguished thus :—

{	The pronotum with a few punctures in the anterior angles, its	
	marginal grooves broad and deep and coarsely punctured	<i>T. thoreyi</i> , p. 112.
{	The pronotum unpunctured except near the scars, its	
	marginal grooves very fine	<i>T. ursulus</i> , p. 112.

Genus **LEPTAULAX**, Kaup, 1868a, p. 11.

Incl. *Leptaulacides*, Zang, 1905a, p. 106, footnote 1.

Type, *Passalus dentatus*, Fabricius, 1792, p. 241.

The account of this genus which I published in 1914 was based mainly on the examination of specimens from Continental Asia. I had, it is true, received a few specimens from the Archipelago; and I was able to make a hurried examination of the named collection in Berlin. But I had had no opportunity of examining a large and representative collection at leisure, an opportunity which has now been afforded by the obtaining of the Van de Poll collection for the Indian Museum.

The careful examination of this additional material convinces me that the drastic reduction in the number of species, advocated in my previous paper, was fully justified except in the case of *L. barbicauda*, Zang; and, indeed, that a few further reductions must be made. Thus *L. obtusidens* proves to be a synonym of *L. bicolor*; and *L. novaeguineae*, together with the names regarded as synonyms with it, are almost certainly synonyms of the same species, or partly of the same species and partly of *L. dentatus*.

I have seen nothing in the collection that can be distinguished as *L. macassariensis*; but a specimen labelled with this name, and associated with specimens both of *L. bicolor* and *L. dentatus*, proves to belong to the former species. I am still inclined to think, judging from Schaufuss's description, that the type may prove to be of a distinct species, the puncturing of the head being apparently much coarser than in *L. bicolor*, and the convexity

of the body much greater than in *L. cyclotaenius*, the only other species known to me from Celebes with which it can possibly be identified. But for the present it seems best to drop the name *macassariensis*, raising the Bornean *anibarbis* to specific rank.

The variation of *L. cyclotaenius* in size, form, and head-puncturing proves to be much greater than I previously supposed, especially in Malaysian specimens; and the distinction between the Malaysian and continental races breaks down. The name *himalayae* therefore becomes a synonym only. *L. anipunctus* is very near *L. cyclotaenius* and may prove to be identical with it. For the present it seems best to regard it as a variety of that species.

I am no longer able to regard the varieties *vicinus* and *glabriventris*, of *L. bicolor* and *dentatus* respectively, as distinct.

The three species *L. bicolor*, *L. cyclotaenius* and *L. dentatus* are so variable as to require very special care in their discrimination. The first and third can always be told apart by the structure of their parietal ridges, which extend outwards to the supraorbital ridges in the former, and end abruptly not far from the central tubercle in the latter. In *L. cyclotaenius* these ridges are variable; but the puncturing of the lateral grooves of the elytra is much more distinctly scalariform than is ever the case in *L. bicolor* (this is usually, but not always, so in *L. dentatus* also); and the central area of the metasternum is almost invariably punctured either irregularly or over a more or less V-shaped area, punctures being absent or confined to a single symmetrically placed pair in *L. dentatus*. In the rare cases where the general appearance of the specimen resembles that of *L. cyclotaenius*, and the central area of the metasternum is entirely without punctures—I have only seen one such, and very few in which these punctures were not at least moderately numerous, all of these being from Sumatra or the Malay Peninsula—one can only base one's identification on the somewhat indefinite and variable characters afforded by the shape of the frontal ridges and the puncturing of the head.

***Leptaulax planus* (Illiger).**

Passalus planus, Illiger, 1800, p. 104.

Leptaulax planus, Gravelly, 1914c, pp. 260-261 and 310, pl. xiii, fig. 58.

One specimen from Siam, nine from the Malay Peninsula (four of them from Perak, and one from Larut), many from Sumatra (Bedagei Interior, ca. 600 ft.; Tandjong Morawa; Serdang; S. E. Serdang, ca. 1,000 ft.; Png. Pandjang, Padung Interior, ca. 2,000 ft., Tandjong-Djati, Ranau, Palembang, ca. 2,000 ft.) and Borneo (Sarawak; Brunei; Doesonlanden; Martapura; Mt. Marapok, Dent Province; Mt. Kina-Balu) and one from Celebes (Tondano, Minahassa). M. Guy Babault has sent specimens for examination from Medan, Sumatra. Length 12.3-14.0 mm.

***Leptaulax glaber* (Kirsch).**

Trichostigmus glaber, Kirsch, 1877b, pp. 139-149.

Leptaulax glaber, Gravelly, 1905c, p. 307.

One specimen from Batjan and four from New Guinea (Humboldt Bay, Mt. Arfak and Takar). Length 14.0-15.8 mm.

But for the reddish-brown colouration commonly found on the anterior parts of the elytra, this species might easily be confused with small and much flattened specimens of the

Polynesian form of *L. bicolor*. The specimens before me, however, show the extent of this colouration to be extremely variable; for in one of the Humboldt Bay species it covers about a half and in the other about a third of the whole area, while in a third specimen from New Guinea it is confined to a somewhat indistinct patch between the shoulders and in the fourth it is entirely absent. The chief characteristics of the species, apart from colour, are its extreme flatness, the fineness of the marginal grooves of the pronotum, and the almost entire absence of punctures from the pronotum and metasternum. The frontal ridges extend outwards and slightly forwards, to end somewhat abruptly at a considerable distance behind the outer marginal tubercles.

Leptaulax sambawae, n. sp.

Four specimens from B. Aroe Hassa, Sambawa, 2,000-5,000 ft., and two from Poera, Allor Islands, 3,000-4,000 ft. Length 24-27 mm.

This species differs from *L. bicolor* only in having the pronotum somewhat less distinctly rectangular in shape, and entirely unpunctured except somewhat indistinctly in the scars and still more indistinctly in the marginal grooves; in having the punctures on the posterior intermediate areas of the metasternum more or less obsolete; and in having the elytra distinctly wider behind than in front with their lateral grooves much less strongly punctured. The abdominal sterna are polished and are entirely unpunctured in two specimens, the terminal segment being marked in others with hair-bearing punctures.

Leptaulax barbicauda (Zang).

Leptaulacides barbicauda, Zang, 1905a, pp. 164-165.

Several specimens from the Malay Peninsula, (Gap, ca. 3,000 ft., Selangor-Pahang boundary) submitted by Mr. C. Holman Hunt. Length 27-30 mm.

This species is transitional between *L. sambawae* and *L. bicolor*, and is so near the latter most variable species that I have some hesitation in regarding it as distinct. It is, however, distinctly bigger, with large and strongly rectangular pronotum, the general appearance of the insect consequently resembling that of *L. dentatus*. The puncturing of the pronotum and metasternum is weaker than is usually the case in *L. bicolor*, tending to resemble rather that found in *L. sambawae*; there are always, however, a few punctures in the anterior angles of the pronotum, and the punctures in the pronotal scars and on the posterior intermediate areas of the metasternum are somewhat stronger.

Leptaulax bicolor (Fabricius).

Passalus bicolor, Fabricius, 1801, p. 256.

Leptaulax bicolor + var. *vicinus*, Gravely, 1905c, pp. 257-259 and 307-309.

Numerous specimens, including one or more from each of the following localities:—Ceylon (Belihul-Oya); Parambikulam, Cochin State, 1,700-3,200 ft. (collected by myself); Santi Koppa, N. Coorg (presented by Mr. T. Bainbrigge Fletcher); Tukvar, Darjeeling District; Pashok, Darjeeling District, 2,000 ft. (collected by myself); Margherita, Assam; Port Blair, Andamans (collected by Mr. S. W. Kemp); Tonkin (Nape, Thadua, Chapa, Hoabink, and Xieng Khouang, submitted by M. Vitalis de Salvaza; and Cape Fouquet, submitted by M. Guy Babault); Siam; Perak, Malay Peninsula; Gap, 3,000 ft.,

Selangor-Pahang boundary, Malay Peninsula (one specimen sent for examination by Mr. C. Holman-Hunt); Hili Madjedja and G. Madjedja, North Nias; Kalim Bungo, Middle Nias, Sumatra (Bedagei Interior, *ca.* 600 ft.; Beloe Lawang, Pasoeroean; Mana Rieng, Palembang, 2,000-3,000 ft.; Tandjong-Djati, Ranau, Palembang, *ca.* 2,000 ft.; Kandg. Ampat, Lower Padang; Bng. Proepoe, Pad. Bovenland, *ca.* 1,600 ft.; Engano Island, Benkoelen; also specimens from Médan, submitted by M. Guy Babault); Java (Bogor=Buitenzorg; Tji Bodas, Gng. Gede, *ca.* 4,000 ft.; Telega Bodas, Garoet, Preanger, 4,000-5,000 ft.; Mt. Tjikorai, 4,000 ft., Sukabumi, 2,000 ft., and Pengalengan, 4,000 ft., W. Java; G. Tji Salimar, *ca.* 3,000 ft., W. Preanger; Tji Solak, Wunkoops Bay; Mt. Tengger, 4,000 ft., E. Java; Malang); Borneo (Mt. Marapok; Mt. Kinabalu; Sarawak; Pontianak; Doesonlanden; 1° S., 115° E.; Banguay Island); Philippine Islands (Davao: also specimens presented by Mr. C. F. Baker from Imugin, N. Viscaya; Mt. Makiling, Luzon; Zamboanga, Mindanao; Mt. Bonatao and Los Banos); Talaut Islands (Salibabu); Celebes (Lompa-Battau, 3,000 ft., Tjamba and Bantimoeroeng in the south; Menado; Loka, Bonthain); Halmaheira (Gilo); Morty; Ternate; Batjan (Labuan); Wakollo, Central Buru; Ilat, Buru East Coast; Mysol; Kei Islands; New Guinea (Humboldt Bay; Kapaur; Dore; Run). Length 12-24 mm.

In the large and representative collection now before me I find it impossible to subdivide the species satisfactorily into groups distinguished by the amount of puncturing on the abdominal sterna. There is, however, a marked though imperfect correlation of the extent of this puncturing with the localities from which the specimens come, specimens with smooth sterna being characteristic of Ceylon, the Andamans and Nicobars, the Philippines, and the Archipelago east of the Sunda Islands. In specimens from Java the abdominal sterna are as a rule less extensively punctured than in specimens from Sumatra and Borneo; but specimens with absolutely unpunctured abdominal sterna do occur in Borneo and in small islands near Sumatra, if not actually on the mainland.

The form of the mesosternal scars is also variable. Normally they are rounded on the inner side, and are not very large; but in specimens from the archipelago east of Borneo the inner side is usually straight, extending much further backwards. Such forms also occur further west, though more rarely. Celebes specimens appear to occupy a somewhat intermediate position.

In very small specimens from the Archipelago east of Celebes, which are usually extremely flat like *L. planus*, the frontal ridges resemble more or less closely those of *L. glaber*, ending behind the anterior margin of the head and usually between its inner and outer tubercles; and the marginal tubercles of often closely approximated. When a series of specimens is examined, however, this character also proves to be somewhat indefinite, and I am no longer able to regard *L. obtusidens*, Kuwert, as distinct.

The size of the punctures in the lateral grooves of the elytra is very variable both in *L. bicolor* and in *L. dentatus*. As a rule it is much smaller in the former than in the latter, but the difference in the case of extreme specimens is very small. There is never any difficulty, however, in distinguishing the two species from each other, by the structure of the parietal ridges, which extend to the supra-orbital ridges in *L. bicolor*, but end abruptly about half way between the central tubercle and the supra-orbital ridges in *L. dentatus*.

Leptaulax anibarbis, Kuwert.

Leptaulax anibarbis, Kuwert, p. 293.

Leptaulax macassariensis, subsp. *anibarbis*, Gravely, 1914c, pp. 256 and 305-306, pl. xiii, fig. 54.

One specimen from Mt. Kinabalu. Length 22.2 mm.

Leptaulax cyclotaenius, Kuwert.

Leptaulax angustifrons + *cyclotaenius* + *himalayae*, Kuwert, 1898, pp. 285-286.

Leptaulax anipunctus, Zang, 1905a, pp. 234-235.

Leptaulax cyclotaenius + *anipunctus*, Gravely, 1914c, pp. 255-257, pl. xiii, figs. 53 and 55.

A number of specimens of the typical form from the following localities :—Margherita, Assam ; Xieng Khouang, Tonkin and Cambodia (presented by M. Vitalis de Salvaza) ; Perak, Malay Peninsula (also specimens from Gap, 2,700-3,000 ft., Selangor-Pahang Boundary, and foothills of Gunong Hitam, Selangor, Malay Peninsula, submitted by Mr. C. Holman-Hunt) ; Sumatra (Kandg. Ampat, Lower Padang ; Gunung-Agung, Palembang, 5,000 ft. ; S. E. Serdang, ca. 1,000 ft. ; Engano Island, Benkulen Residency ; also specimens from Médan, Sumatra, submitted by W. Guy Babault) ; Borneo (Mts. Kinabalu and Marapok) ; and North Celebes (Tondano, Minahassa ; Toli-Toli).

Also several specimens of the variety *anipunctus*, Zang, from Chapa and Lao Kay, Tonkin, and from Cambodia, presented by Mr. Vitalis de Salvaza.

Length 11.7-20.5 mm.

The varietal form *anipunctus* differs from the typical form only in having the pronotum somewhat sparsely, though extensively, punctured in the anterior angles and round about the scars, instead of densely punctured at the sides from end to end ; and in having the posterior intermediate areas of the metasternum somewhat weakly punctured on the inner side only.

The structure of the head is very variable. The parietal ridges are usually long as in *L. bicolor* in small specimens, and short as *L. dentatus* in larger ones. The latter usually have the surface of the head densely punctured and the frontal area longer than broad ; the former usually have the surface of the head more or less unpunctured and the frontal area broader than long. Very small specimens are usually extremely flat like *L. planus*, larger ones being somewhat stouter ; this is the case in *L. bicolor* also.

Leptaulax dentatus (Fabricius).

Passalus dentatus, Fabricius, 1792, p. 241.

Leptaulax dentatus + var. *glabriventris*, Gravely, 1914c, pp. 252-255, pl. xiii, figs. 52-52d.

Numerous specimens from the following localities :—Madras ; Nepal ; Darjiling District (Tukvar, Van de Poll collection ; Singla, presented by H. E. Lord Carmichael ; and Kalimpong, presented by myself) ; Tonkin (Lao Kay, Vientiane, Hoabink, Napé), Laos (Kham-Keut) and Cambodia (Kompong Kedey) submitted by M. R. Vitalis de Salvaza ; Renong, Siam ; Karen Hills, Burma, 4,000 ft. ; Andamans (Port Blair, presented by Mr. S. W. Kemp) ; Penang ; Perak, Malay Peninsula ; Carey Island (presented by Mr. C. Holman-Hunt) ; Hili Madjedja, N. Nias ; Kalim Bungo, Middle Nias ; Sumatra (Médan, submitted by M. Guy Babault ; Tanjong-Djati, ca. 2,000 ft. and Mana-Riang, 2,000-3,000 ft., Renau, Palembang ; S. E. Serdang, E. Coast, ca. 1,000 ft. ; Bedagei

Interior, East Coast, ca. 600 ft.; Kandg. Ampat, Lower Padang); Java (Malang; Tengger Mt., 4,000 ft.; Tjicopo; Boeloe Lawang, Pasoeroean; Senggoro, southern Pasoeroean; Central Java, 1,500 ft.); Bali; Borneo (Mts. Kinabalu and Marapok; Doesonlanden; Martapura, S. E. Borneo); Philippines (Mindoro; S. Palawan; Balabac: also specimens presented by Mr. C. F. Baker from Imugin, N. Vissale; Mt. Makiling and Limay, Luzon; Iligan, Mindanao; Mt. Banalao; and Los Banos); Taruna, Great Sangir; Celebes (Tondano; and Tangari, Minahassa, Menado and Toli-Toli in the north; Bonthain, Bua-Kraeng 5,000 ft., Tjamba and Bantimurang in the south); Sapit, Lombok, 2,000 ft.; Buru (North Coast; Kajeli; Iliat, East Coast; Wae Kibo; Tifu Bay); Hitu, Amboina; Ceram (Wahaai; Rumasosal-Pasania; Kairatoe) Buano; Nus Laut. Also a specimen said to come from British Honduras, and others from the following localities which I have been unable to trace:—Sula Besi (Doherty); Labunarang, Andonara (Doherty); Pach. (Mouhot); Mat. (Wallace). Length 17.5-32.7 mm.

The puncturing of the abdominal sterna is very variable and proves, as in *L. bicolor*, to be of no use for the distinction of definite varieties—hence the name *glabriventis* becomes a synonym. The central area of the metasternum bears at most a pair of symmetrically placed punctures. It never bears irregular punctures such as are ordinarily characteristic of *L. cyclotaenius*.

***Leptaulax timoriensis* (Percheron).**

Passalus timoriensis, Percheron, 1841, pp. 19-21, pl. lxxviii, fig. 1.

Leptaulax timoriensis, Zang, 1905c, p. 223.

Three specimens from Gng. Leo, Dutch Timor, 2,000-4,000 ft.; five from Dilli, Port Timor, 2,500 ft.; one from Ilwaki, Wetter; and two from the Alor Islands. Length 24-35 mm.

This species is very near *L. dentatus*, being distinguished only by the structure of the pronotum, which is less distinctly rectangular, and is unpunctured in the anterior angles, except in very small specimens in which one or two punctures may be present in this position. In small specimens the puncturing in and around the pronotal scars and marginal grooves is more extensive than in large ones.

***Leptaulax anna*, Zang.**

Leptaulax anna, Zang, 1905a, p. 316.

Four specimens from B. Aru Hassa, Sambawa, 2,000-5,000 ft. Length 30-31 mm.

L. anna is very like *L. timoriensis*, but has the pronotal scars less densely punctured, has the elytra more distinctly broadened behind with their lateral grooves matt and marked with somewhat worn-looking punctures, and has the metasternum hairy laterally and in front. In the Van de Poll specimens (30-31 mm. long) the lateral and intermediate areas of the metasternum are united; but in a smaller specimen in our collection (26 mm. long and a co-type) they are distinct, though the ridge between them is somewhat weak behind. The elytra are separate.

Leptaulax humerosus, Kuwert.

Leptaulax humerosus, Kuwert, 1898, p. 289.

Leptaulax humerosus, Gravely, 1914c, pp. 251-252, pl. xiii, fig. 51.

Numerous specimens from the following localities :—Perak, Malay Peninsula ; Sumatra (Mana-Riang, 2,000–3,000 ft., and Tandjong-Djati, ca. 2,000 ft., Renau, Palembang ; Bng. Proepoe, Padang Interior, ca. 6,000 ft. ; S. E. Serdang, ca. 1,000 ft. and Bedagei Interior, ca. 600 ft., East Coast ; Beloe Lawang, Pasoeroean) ; Java (Malang ; Pengalengan, S. Preanger, 4,000–5,000 ft. ; G. Gedeh, N. W. Preanger, 4,000 ft. ; Telaga Bodas, Garoet, Preanger, 4,000–5,000 ft. ; G. Tji Salimar, W. Preanger, 3,000 ft. ; Tengger Mountain, E. Java, 4,000 ft.) ; Borneo (Martapura and Kinabalu). Length 15·8–22·5 mm.

Easily distinguishable from *L. anna*, which it resembles as regards the sculpturing of the elytra, by its smaller size, by its more strongly rectangular pronotum with thickly punctured sides and more or less prominent anterior angles, and by its slenderer elytra.

The species of *Leptaulax* which I have been able to recognize may be distinguished from one another thus :—

- | | | | |
|---|---|--|-----|
| 1 | { | The elytra polished throughout | 2. |
| | | The depressed surface of the two or three outermost grooves of the elytra dull, the punctures somewhat worn-looking | 11. |
| 2 | { | The puncturing of the lateral grooves of the elytra not strongly transverse ; the parietal ridges united with the supraorbital ridges | 3. |
| | | The puncturing of the lateral grooves of the elytra strongly transverse ; or, the parietal ridges ending more or less abruptly about half way to the supraorbital ridges | 8. |
| 3 | { | The abdominal sterna covered evenly all over with somewhat obscure, broad, shallow punctures <i>L. planus</i> , p. 113. | |
| | | The puncturing of the abdominal sterna variable in extent, sometimes absent, when present always finer, and when extensive deeper and less uniform | 4. |
| 4 | { | The marginal grooves of the pronotum extremely fine, their puncturing more or less obsolete ; the sides of the pronotum and the posterior intermediate areas of the metasternum at most weakly punctured | 5. |
| | | The marginal grooves of the pronotum coarser, strongly punctured ; the sides of the pronotum and the posterior intermediate areas of the metasternum as a rule strongly and extensively punctured | 7. |
| 5 | { | The pronotum strongly rectangular, the elytra more or less parallel-sided ; small insects, not more than 18 mm. long | 6. |
| | | The sides of the pronotum somewhat rounded, the elytra more or less dilated behind ; large insects, not less than 24 mm. long <i>L. sambawae</i> , p. 114. | |

- 6 { The frontal ridges ending in the inner marginal tubercles ;
insects always unicolorous above *L. roepstorfi*, Kuwert.
- 6 { The frontal ridges extending parallel to the anterior margin
of the head to a point between the inner and outer marginal
tubercles, where they end somewhat abruptly ; the anterior
parts of the elytra commonly reddish brown in otherwise
black insects *L. glaber*, p. 113.
- 7 { Large insects (over 28 mm. long) ; the puncturing of the
pronotum and metasternum very scanty *L. barbicauda*, p. 114.
- 7 { Smaller insects (not more than 25 mm. long) ; the puncturing
of the pronotum and metasternum much denser *L. bicolor*, p. 114.
- 8 { The parietal ridges united with the supraorbital ridges ; the
central area of the metasternum unpunctured *L. anibarbis*, p. 116.
- 8 { The parietal ridges ending more or less abruptly about half
way to the supraorbital ridges ; or, the central area of the
metasternum punctured 9.
- 9 { The central area of the metasternum almost invariably with
at least a few more or less irregularly placed punctures ; the
parietal ridges variable *L. cyclotaenius*, p. 116.
- 9 { The central area of the metasternum with at most one pair of
symmetrically placed punctures ; the parietal ridges always
ending more or less abruptly about half way to the
supra-orbital ridges 10.
- 10 { The pronotum strongly rectangular ; its anterior angles more or
less extensively punctured *L. dentatus*, p. 116.
- 10 { The pronotum more rounded ; its anterior angles unpunctured,
except in small specimens, where a small group may be
present *L. timoriensis*, p. 117.
- 11 { The grooves of the elytra not tuberculate 12.
- 11 { A more or less distinct polished tubercle formed out of each
of the transverse ridges in the lateral grooves of the elytra .. *L. beccarii*, Kuwert.
- 12 { The pronotum convex, punctured only in the scars and
marginal grooves and usually in the anterior angles ; the
elytra short, dilated behind ; the metasternum hairy
laterally and in front, its lateral and intermediate areas
often united *L. anna*, p. 117.
- 12 { The pronotum somewhat flattened, densely punctured laterally,
its sides practically straight ; the elytra slender, more or less
parallel sided ; the metasternum hairless, the intermediate
and lateral areas always distinct *L. humerosus*, p. 118.

ZOOGEOGRAPHICAL RESULTS.

It would be useless to attempt to give here a detailed account of the distribution of the various species of Passalidae. For in the case of Oriental genera the information gathered together in my "Account of the Oriental Passalidae" can readily be supplemented by the

additional records contained in the present paper; and in the case of other genera no compilation is possible without a much more detailed revision of synonymy than I am at present able to achieve. But the general distribution of the family requires some further consideration in the light of certain facts set forth in the present paper.

It will be convenient to deal with the Indo-Australian area first.

This area is inhabited by three subfamilies of Passalidae, namely the Aulacocyclinae, Macrolininae and Leptaulacinae.

The Aulacocyclinae, though not a very large subfamily, appears to be a somewhat highly specialized one. In none of its species are there frontal and parietal ridges or inner and outer tubercles, such as are found in the more primitive species of all other subfamilies; and in the three largest genera, *Comacupes*, *Taeniocerus* and *Aulacocyclus* the basal piece and lateral lobes of the male genital tube form one piece, either by consolidation or by the suppression of the basal-piece, instead of being separate as in other subfamilies (see Sharp and Muir, 1912, p. 580; also above, p. 5), while the middle lower tooth on each mandible is immovable. In all other Passalidae, even in such primitive forms as *Oileoides subrecticornis*, this tooth is jointed. Jointing does not occur, so far as I know, in any beetles other than Passalids, and is clearly an indication of specialization; but its absence in *Comacupes*, *Taeniocerus* and *Aulacocyclus* is probably secondary and not primitive, especially as it is correlated with specialization of the male genital tube. In the two remaining genera, *Ceracupes* and *Cylindrocaulus*, the structure, both of the tooth in question and of the male genital tube, resemble those found in other subfamilies.

The largest genus, *Aulacocyclus*, is centred in the Australian Region, but extends into the Sunda Islands and Indian Peninsula. This discontinuous distribution suggests that ground is being lost in the Oriental Region, where the smaller genera *Comacupes* and *Taeniocerus* predominate. These genera are confined to the Oriental Region, except for a single species of *Comacupes* (*C. foveicollis*) which has established itself in Celebes. Only one species, *Taeniocerus bicuspis*, is found north of the Malay Peninsula; this extends northwards to the Himalayas.

The genera *Ceracupes* and *Cylindrocaulus*, in which the male genital tube and middle lower tooth resemble those of other subfamilies, only occur towards and beyond the northern confines of the Oriental Region. With these presumably primitive characters they combine cephalic excrescences which give them a most unusual appearance. Such excrescences frequently indicate the senility of a group, and it seems probable that *Ceracupes* and *Cylindrocaulus* are senile survivors of a transitional group through which the more typical Aulacocyclinae of the present time have been derived. *Ceracupes* is less abnormal than *Cylindrocaulus* and occurs in Burma, the Himalayas, Tonkin and Formosa. The latter only occurs still further north, namely in China and Japan. Its species are the only Aulacocyclinae known to have fused elytra.

The Macrolininae fall into two series of genera, whose distribution must be considered separately. The first of these comprises the genera *Macrolinus* and *Pleurarius*, whose combined range covers the Oriental Region and Celebes, but does not extend into the Papuan Sub-Region. Ceylon is occupied by species of *Macrolinus* which are closely allied to one another but differ in certain characters, common to all of them, from the remaining

species of the genus.¹ The genus *Pleurarius* appears entirely to replace *Macrolinus* in the Indian Peninsula. This genus has otherwise been recorded only from Sumatra, whence it was originally described. In the absence of further records from that island I am inclined to doubt the validity of the record and to believe the genus to be confined to the Indian Peninsula. If this is so the genus probably contains one species only, a species whose elytra are united. Other groups of *Macrolinus* occupy respectively (1) the Indo-Chinese Sub-Region, (2) the Malayan Sub-Region and (3) Celebes, except that one rare Celebean species belongs to the Malayan group. Species of *Macrolinus* with fused elytra are known only in the Ceylonese and Celebean groups.

The second series of genera of Macrolininae (Pl. I) is found throughout the Indo-Australian area and is remarkable for the pronounced asymmetry which is developed in most of its more highly specialized members. It comprises the *Aceraiinae* and *Gnaphalocneminae* of my previous papers, one of which was devoted to a special study of its distribution (1914b).

The study of more extensive material fully confirms the geographical separation, in Ceylon and Australia respectively, of the primitive and closely related symmetrical forms by the more highly specialized and less closely related descendants of each; but shows that I was mistaken in confusing the Celebean Passalid fauna with the Papuan, and that my suggestions regarding phylogeny can be improved upon.

Concerning the distribution of the genera *Episphenus*, *Ophrygonius* and *Aceraius* there is nothing fresh to add. The first named is confined to the Indian Peninsula and Ceylon, the two last to the rest of the Oriental Region. The species inhabiting Ceylon are less highly specialized than those inhabiting the Indian Peninsula, which in their turn are less highly specialized than those found on the other side of the Ganges, taking these as a whole. And in each of these areas the most asymmetrical (*i.e.*, the most highly specialized) is also the most abundant, the most variable, and among the largest. It also has gregarious habits (Gravely, 1914b, pp. 202-204; 1914c, pp. 311-313).

Similarly, in the genus *Pelopides*, the most abundant species in the Sunda Islands are large and highly asymmetrical (*P. tridens*, etc.); but in the Malay Peninsula the most abundant species (*P. dorsalis*) is smaller and more nearly symmetrical. The most symmetrical species of all appears to be confined to Borneo, the island where a primitive form would be least expected; but it does not seem to be common there.

The genus *Pelopides* is found all over the Malayan Sub-Region, and extends beyond it into the extreme south of Burma, but no further. Its connection with simpler genera is obscure, but it would be quite in keeping with the general relationship between the evolution and distribution of asymmetrical Passalids for some ancestral form to be found in Continental Asia. It seems to me possible that such may be represented in the genus *Tiberioides*, a symmetrical genus whose presence in the area occupied by *Ophrygonius* and *Aceraius* does not accord well with any direct relationship with them. If this is the case, the grooves on the mentum of *T. borealis* no doubt represent an early stage in the development of the large secondary scars found in all species of *Pelopides*. Closely allied to *Pelopides* is the genus *Plesthenus*, which is confined to Celebes (see above, p. 96).

¹ For the distinctive characters of the several local groups of species of *Macrolinus* see sections 1-3 of the table on pp. 82-84 above.

The most primitive species of the Australian Region belong to the genus *Mastochilus*, a genus which, like the Oriental *Episphenus*, contains both symmetrical and more or less strongly asymmetrical species. The subgenera *Pharochilus* and *Mastochilus*, which with one exception (*M. pectinigera*, Heller, from New Guinea) are confined to Australia, contain large and robust symmetrical insects. The subgenera *Analaches* and *Cetejus*, which with one exception (*M. australiensis* from Australia) are found in the islands north of Australia, contain smaller and often slighter insects which are almost always more or less asymmetrical. Of the two species of *Episphenus* inhabiting Ceylon the dominant one is slightly asymmetrical, the other, which is symmetrical, being closely allied to it, but much less abundant and of smaller size. In Australia, on the contrary, the various symmetrical species are dominant, the asymmetrical *Mastochilus* (*Analaches*) *australiensis* being comparatively rare; which suggests that *M. australiensis* is a comparatively recent importation and has not been derived directly from its symmetrical compatriots. This suggestion is supported by the fact that *M. australiensis* is much more closely related to Papuan than to Australian species, being indeed one of the most highly asymmetrical members of its genus, and by the fact that it has been recorded from New Guinea as well as from Australia.

The genus *Mastochilus* probably represents the primitive stock from which the genera *Labienus* (with *Protomocoelus*), *Gonatas* and *Pseudepisphenus* (with *Tarquinius*) have been derived.

In *Labienus* specialization affects mainly the metasternum, apparently in association with the wings, which tend to lose their normal function and doubtless to become more efficient stridulating organs at the same time. In the most highly specialized members of the genus, which appear to be confined to the Moluccas, the elytra are united in the middle line, species with separate elytra being apparently to be confined to New Guinea, the Aru Islands, etc.

Protomocoelus appears to have been derived from the simpler forms of *Labienus*. Its dentition is reduced, in which respect it is the most highly specialized of all the species with a modified metasternum. But the elytra are not united nor do they show any tendency to become ovate. The genus occurs in the Solomon Islands and has been recorded from the Moluccas, as well as from the Islands inhabited by the simpler forms of *Labienus*.

The genus *Gonatas* constitutes a second line of descent from *Mastochilus*. The metasternum, wings and elytra are always normal; but the mandibles become very strongly asymmetrical, and the posterior margin of the mentum very strongly arched, in highly specialized forms. The progressive stages of this development are still preserved in the less highly specialized species. The most primitive species of all, *G. minimus*, appears to be confined to New Guinea and its neighbouring islands; but *G. pumilio*, the species most closely allied to it, although occurring there appears to be centred in the Moluccas. Much larger and more abundant than either are *G. schellongi*, *G. germari* and *G. naviculator*, which must be regarded as the dominant species of the genus. *G. schellongi* is somewhat more primitive than either of the others, and is confined to New Guinea, the other two being centred in the Moluccas, though recorded from New Guinea and from Java and the Philippines also.

The third and last line of descent from *Mastochilus* is found in the genera *Pseudepisphenus* and *Tarquinius*, two extremely rare forms known only from New Guinea. Their affinities have already been fully discussed elsewhere (Gravely, 1924c, 328-329).

The Leptaulacinae are centred in the Malayan Sub-Region, whence several have spread westwards and eastwards to the Indo-Chinese Sub-Region and Celebes respectively. The two dominant species, *L. bicolor* and *L. dentatus*, have spread beyond these limits into the Indian Peninsula and Ceylon in the west, and into the Moluccas, New Guinea, and possibly even Australia in the east. Isolated species have arisen in several of the islands or island groups of both the eastern and western parts of the archipelago. The number of distinct species appears, however, to be small and the more widely distributed species especially are extremely variable and often difficult to distinguish from one another. They are also extremely abundant. This probably indicates that the subfamily is of relatively recent origin and that it has not yet reached a condition of equilibrium.

The importance of Palk Strait, the Gangetic Plain, the China Sea and Isthmus of Kra (together), the Straits of Macassar and Torres Strait in the distribution of the Macrolininae has already been pointed out (Gravely, 1914c, p. 338). The further study of the Passalidae of the Australian Region shows that the Molucca and Gilolo Straits are of no less importance and, indeed, that to the former belongs the special importance which I previously attached to the Straits of Macassar, the fauna of Celebes being even more unlike that of the Australian Region than it is unlike that of the Oriental Region.

The Passalids hitherto recorded from Celebes are as follows :¹—

<i>Comacupes foveicollis</i> subsp. <i>minor</i>	..	..	{ Genus otherwise purely Oriental; <i>C. foveicollis</i> , s. str., confined to Borneo.
<i>Aulacocyclus celebensis</i>	..	..	Endemic. Genus Indo-Australian.
<i>Macrolinus sulciperfectus</i>	..	..	{ Endemic. Belongs to the group of <i>Macrolinus</i> other- wise known only from the Malayan Subregion.
„ <i>duivenbodei</i>	..	..	{ These two constitute a group which is endemic.
„ <i>urus</i>	..	..
<i>Aceraius laevicollis</i>	..	..	{ A Malayan species. The genus is so definitely Oriental that I am inclined to doubt this record.
<i>Plesthenus</i> spp.	..	..	Endemic. Allied to the Oriental <i>Pelopides</i> .
<i>Trichostigmus ursulus</i>	..	..	{ Endemic. The only other known species of the genus is Oriental.
<i>Leptaulax planus</i>	..	..	{ Oriental species which appear to be extending their range. One at least has reached New Guinea and possibly Australia.
„ <i>bicolor</i>	..	..
„ <i>cyclotaenius</i>	..	..
„ <i>dentatus</i>	..	..

Although a large proportion of these species are endemic, and it is doubtful whether either of the two most characteristic asymmetrical Oriental genera, *Aceraius* and *Pelopides*, occur in Celebes at all, it will be seen that every species known from Celebes is related to species which are essentially Oriental, although some have established themselves in the Australian Region also.

¹ Concerning Kuwert's record of "*Pelops*" *impressicollis* see above, p. 107, footnote 2.

The Passalid fauna of the Moluccas is closely allied to that of New Guinea, and several species have been recorded as common to both. In the genus *Gonatas*, however, it is noteworthy that of the two species with most primitive mentum the one with complete dentition is only known from New Guinea; while of the three common species with more highly specialized mentum the one with the most primitive dentition seems to be confined to New Guinea and the other two to the Moluccas. Similarly, in the genus *Labienus*, species with normal elytra appear to be confined to New Guinea and those with fused elytra to the Moluccas. The allied *Protomocoelus*, in which the mandibles are modified instead of the elytra, belongs however to New Guinea, and, although it is undoubtedly more widely distributed than any of its allies, the single record of its occurrence in the Moluccas should be confirmed before it is finally accepted. *Pseudepisphenus* and *Tarquinius* are only known from New Guinea.

The information at present available regarding the distribution of American and Ethiopian Passalidae is much less satisfactory than that regarding the Indo-Australian subfamilies. The probable distinctness of the American and Ethiopian Passalid faunas, in spite of several records to the contrary, has already been dealt with (above, pp. 10-11). It is perhaps worthy of note here that no Ethiopian Passalidae are known to have the elytra united, and that in America, although species with fused elytra attain the largest size, the commonest and most widely distributed species have separate elytra. Among the Pseudacanthinae *Popilius cornutus* is the largest and most highly specialized of the species with separate elytra and is the commonest and most widely distributed species in the subfamily. Among the Proculinae no species appears to be exceptionally abundant. Among the Passalinae *Paxillus leachii*, *Passalus interstitialis* and *Passalus interruptus* are particularly abundant and widely distributed. The last named is probably the most abundant and widely distributed of all, and is also extremely variable. The group of species to which it belongs appears to me to be the culminating point of the general trend of evolution throughout its genus, a genus whose wealth of closely interrelated species suggests that it bears the same kind of relation to the rest of the American Passalid fauna as *Leptaulax* does to the rest of the Indo-Australian.

SUMMARY.

1. *External Morphology.*

The clypeus is exposed and separated by a suture from the frons only in the subfamily Pseudacanthinae. In a few other genera, mostly American, it is exposed but united to the frons. In the majority of Passalids the whole of the upper surface of the anterior part of the head, between the supra-orbital ridges and in front of the frontal ridges, is frons, the whole of the clypeus being doubled beneath this out of sight (pp. 1-3, fig. i, 1-4).

It is uncertain whether the inner and outer marginal tubercles of the Leptaulacinae are homologous with the inner and outer tubercles respectively of other Passalidae (pp. 3-4).

The dentition is reduced only in somewhat highly specialized forms. In American subfamilies it seems to be associated with the loss of the habit of flight, and to come about

through the fusion of the two lowest terminal teeth. In Indo-Australian subfamilies it is always associated with cephalic asymmetry and never with the loss of the habit of flight, and comes about through the fusion of the anterior lower and lowest terminal teeth (pp. 9-10, fig. ii).

The loss of the habit of flight appears to allow of greater specialization of the wings as stridulating organs. It produces definite structural modifications in the insect (pp. 4-5). The following genera contain, so far as is known, only flightless forms:—*Cylindrocaulus*, *Platyverres*, *Pleurarius*, *Proculejoides*, *Proculejus*, *Procululus*, *Proculus*, *Pseudacanthus* and *Publius*. The following species are also flightless:—*Labiensus moluccanus* and *gigas*, *Macrolinus obesus* and *ursus*, *Passalus quitensis* and *Vindex synelytris*.

The structure of the male genital tube is almost uniform throughout the family. The genera of Aulacocyclinae other than *Ceracupes* and *Cylindrocaulus* differ, however, from the rest of the family in that the basal piece and lateral lobes are represented by one undivided plate (p. 5).

The central tubercle is usually larger in females than in males in species in which it varies greatly in size (p. 5).

2. Classification.

Seven subfamilies have been recognized, of which one, the Aulacocyclinae, confined to the Indo-Australian area with China and Japan, is somewhat widely removed from all the others (p. 9). Two others are confined to the Indo-Australian area. These are distinguished from American and Ethiopian subfamilies by the structure of the mandibles (p. 9). The Ethiopian subfamily is distinguished from the four American ones by the structure of the anterior margin of the head (pp. 10-11).

The number of genera has been greatly reduced. Specific synonymy has not been dealt with, but there can be little doubt that a similar reduction is required in the number of species.

3. Geographical Distribution.

Passalidae appear to flourish only under more or less moist tropical conditions.

American, Ethiopian and Indo-Australian forms belong respectively to different subfamilies, probably without exception (pp. 9-12).

The group of Macrolininae with strong asymmetrical tendencies is of special zoogeographical interest. Its most primitive species inhabit Ceylon and Australia. These are closely allied to one another but give rise to divergent lines of descent, confined respectively to the Oriental Region with Celebes, and to the Australian Region. Both these regions are composed of a series of smaller areas, each characterized by a distinct Passalid fauna, which is more highly specialized in those nearer to Celebes than in those further away. These areas are: in the Oriental Region—Ceylon, the Indian Peninsula, the Indo-Chinese Subregion and the Malayan Subregion; and in the Australian Region—Australia, New Guinea and the Moluccas (pp. 120-124). These facts bear out the suggestion (Gravely, 1913, p. 204) that conditions towards the centre of the Archipelago are peculiarly favourable for evolution, and that as more and more highly specialized forms have arisen there, they have migrated outwards, driving before them the less highly

specialized, which have rarely survived except where they have been able to establish themselves behind some obstacle to migration.

The fauna of Celebes, though related to the Oriental fauna, is very distinct from it, and contains a large proportion of endemic species and one endemic genus (p. 123).

The genera *Macrolinus* and *Pleurarius* are Oriental. The former genus has produced local races in Celebes and in each of the areas into which the Oriental Region proper has been divided above, with the single exception of the Indian Peninsula where it is replaced by the latter genus (pp. 120-121).

The Leptaulacinae appear to be centred in the Malayan Subregion and to be undergoing rapid development and expansion (p. 123).

The Aulacocyclinae appear to be a very highly specialized subfamily, now on the decline. The genera *Ceracupes* and *Cylindrocaulus* appear to be the senile representatives of an old group, in some respects more primitive than the forms at present dominant in the subfamily. They are only found towards and beyond the limits of distribution of the rest of the subfamily (p. 120).

The Solenocyclinae appear to be peculiar to the Ethiopian Region, and the Pseudacanthinae, Proculinae and Passalinae to America. The information at present available as to their distribution is much less complete than is that available concerning Indo-Australian forms (pp. 5 & 124).

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Synonyms are printed in italics : page numbers referring to keys, descriptions, locality or synonymic records, and figures are printed in ordinary type ; other numbers are in bold face.

The summary of the paper on pp. 124-126 has been designed partly as a guide to the whereabouts of the principal facts recorded. References to it are not included in this index. References to the list of recently described genera and species on pp. 7-9 have similarly been omitted.

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EXPLANATION OF PLATE I.

Diagram illustrating the evolution and distribution of the Macrolininae.

The somewhat isolated genera *Macrolinus* and *Pleurarius* have been omitted. The latter is probably confined to the Indian Peninsula,¹ and the former to other parts of the Oriental Region and Celebes.

The species used in the preparation of the diagram are as follows:—

<i>Aceraius grandis</i> ..	..	<i>Aceraius</i> dominant sp., E. Himalayas to Borneo.
„ <i>helferi</i> ..	..	„ other spp., E. Himalayas to Borneo.
<i>Episphenus comptoni</i>	..	<i>Episphenus</i> dominant sp., Ceylon.
„ <i>indicus</i>	..	„ dominant sp., Indian Peninsula.
„ <i>moorei</i>	..	„ other spp., Ceylon.
„ <i>neelgherriensis</i>	..	„ other spp., Indian Peninsula.
<i>Gonatas minimus</i> ..	..	<i>Gonatas</i> simplest sp., New Guinea, etc.
„ <i>naviculator</i>	..	„ only sp. shown, Moluccas.
„ <i>schellongi</i> ..	..	„ dominant sp., New Guinea, etc.
<i>Labienus compergus</i>	..	<i>Labienus</i> other spp. (left), New Guinea, etc.
„ <i>dohrni</i> ..	..	„ other spp. (right), New Guinea, etc.
„ <i>gigas</i> ..	..	„ spp. with fused elytra, Moluccas.
„ <i>trigonophorus</i>	..	„ simplest sp., New Guinea, etc.
<i>Mastochilus australiensis</i>	..	<i>Mastochilus</i> asymmetrical sp., Australia.
„ <i>nitidulus</i>	..	„ symmetrical spp., „
„ <i>peltostictus</i>	..	„ only sp. shown, Moluccas, New Guinea, etc.
<i>Ophrygonius inaequalis</i>	..	<i>Ophrygonius</i> only sp. shown, E. Himalayas to Borneo.
<i>Pelopides dorsalis</i> ..	..	<i>Pelopides</i> other spp., E. Himalayas to Borneo.
„ <i>symmetricus</i>	..	„ simplest sp., E. Himalayas to Borneo.
„ <i>tridens</i> ..	..	„ dominant spp., E. Himalayas to Borneo.
<i>Plesthenus invitus</i> ..	..	<i>Plesthenus</i> other sp., Celebes.
„ <i>quadricornis</i>	..	„ dominant sp., Celebes.
<i>Protomocoelus australis</i>	..	<i>Protomocoelus</i> only sp. shown, New Guinea, etc.
<i>Pseudepisphenus perplexus</i>	..	<i>Pseudepisphenus</i> only sp. shown, New Guinea, etc.
<i>Tarquinius paradoxus</i>	..	<i>Tarquinius</i> only sp. shown, New Guinea, etc.
<i>Tiberioides kuwertii</i>	..	<i>Tiberioides</i> only sp. shown, E. Himalayas to Borneo.

¹ See above, p. 121.

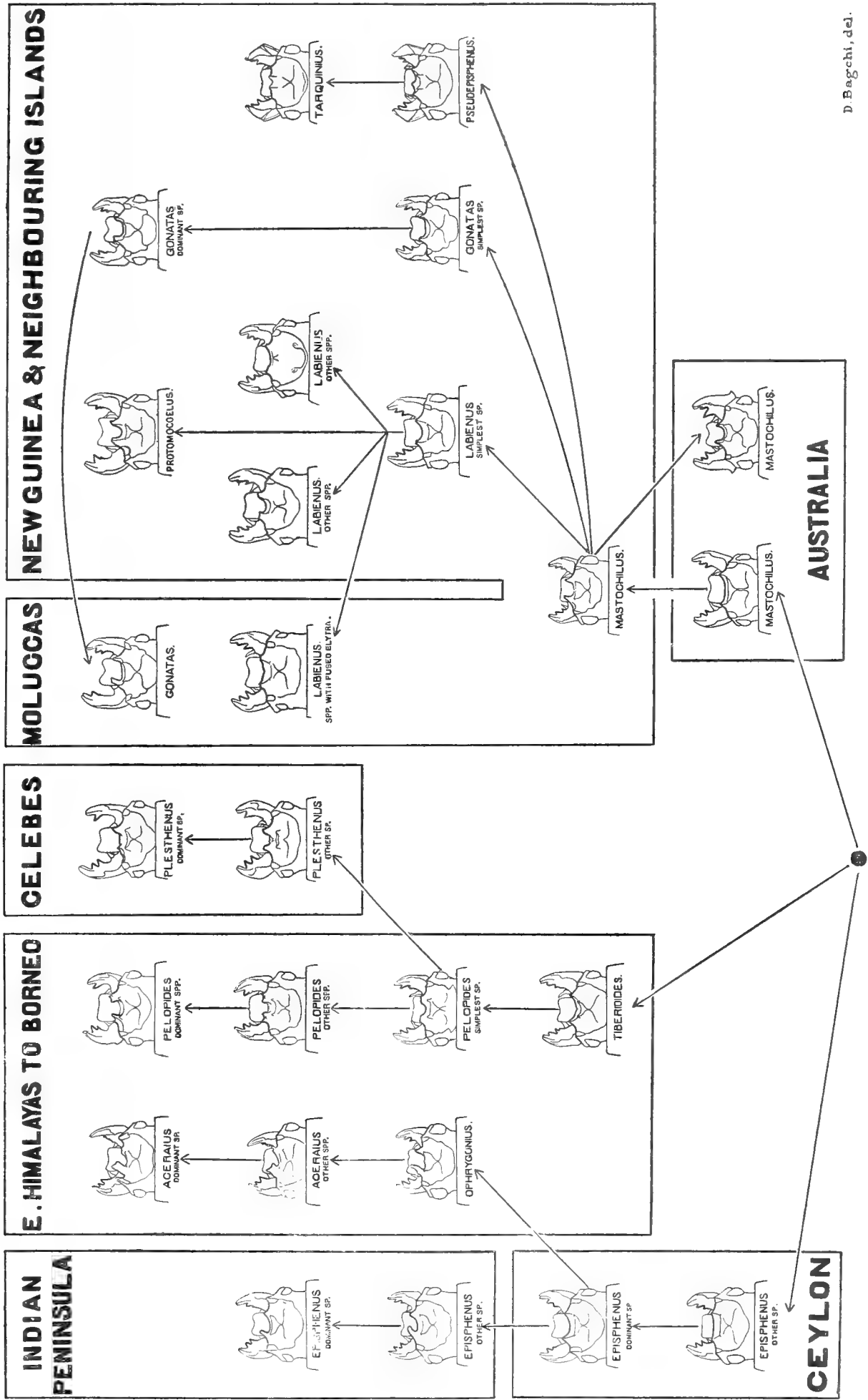


DIAGRAM ILLUSTRATING THE EVOLUTION AND DISTRIBUTION OF THE MACROLININAE.

MEMOIRS OF THE INDIAN MUSEUM

Vol. VII, No. 2.



OBSERVATIONS ON THE SHELLS OF THE FAMILY DOLIIDAE.

BY

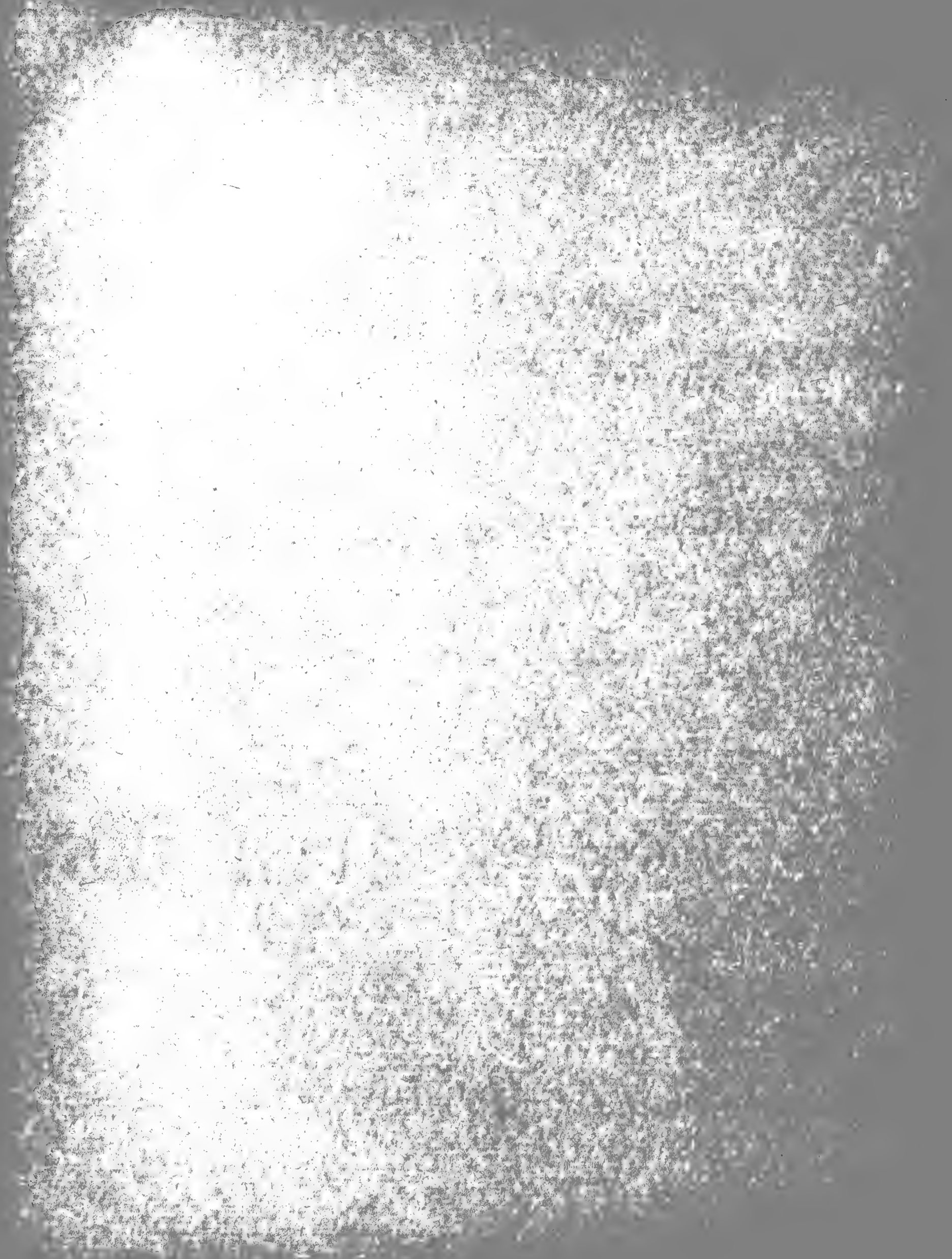
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OBSERVATIONS ON THE SHELLS OF THE FAMILY DOLIIDÆ.

By E. W. VREDENBURG, B.L., B.Sc., A.R.S.M., A.R.C.Sc., F.G.S.,

Superintendent, Geological Survey of India. (Communicated

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(With Plates II—VIII.)

I.—NOTE ON *DOLIUM* (*EUDOLIUM*) *FASCIATUM* (BRUGUIÈRE), AND ON THE SUB-GENUS *EUDOLIUM*.

In Volume V of the *Records of the Indian Museum* (1910, p. 34), Mr. H. B. Preston has figured a remarkable specimen of *Dolium* from Balasore Bay, characterised by the presence, on the body-whorl, of a varix situated at an angular distance of about 35° from the thickened outer lip. The shell has been described as a new species under the name of *Dolium varicosum*. The collections of the Indian Museum include four more specimens exhibiting a similar feature: two from Hong-Kong, one from Vizagapatam, and another from the collections of the Asiatic Society, the exact origin of which is unknown. As has been pointed out to me by Dr. Annandale, three of these shells, including one of the Hong-Kong examples, are specimens of *Dolium fasciatum* (Bruguière), to which species evidently belongs also the Balasore specimen to which Mr. Preston has already drawn attention. The Balasore specimen had long been dead at the time when it was collected, for it is greatly corroded, overgrown internally as well as externally by encrusting organisms (oysters, barnacles, *Serpula*, and polyzoa), while no trace remains of the coloured bands which form so characteristic a feature of *Dolium fasciatum*. Amongst the four varicose specimens of *Dolium fasciatum* preserved in the collection, the Balasore specimen is remarkable as the smallest, measuring 57×40 mm.,¹ while the dimensions of the Hong-Kong specimen are 100×74 mm., of the Vizagapatam specimen 86×65 mm., and of the specimen of uncertain origin 82×60 mm. It should be kept in mind that the three localities from which varicose specimens are known to have been obtained, that is Balasore, Vizagapatam and Hong-Kong, have also yielded normal specimens, and also that the latter often far exceed in size the varicose individuals. For instance, one of the specimens from Balasore Bay, in which there is no super-

¹ The terminal growth of this stunted specimen is abnormal: the outer lip being posteriorly distorted so as to communicate an unusually narrow outline to the posterior part of the aperture and to the general ventral appearance of the shell. This anomaly does not affect the penultimate varix which possesses the normal shape of the aperture of other specimens, so that, viewed dorsally, the shell exhibits the usual globose-ovoid outline.

numerary varix, measures 115×89 mm. Nevertheless, as there is never more than one pre-apertural varix, and as, when present, it is invariably situated close to the final aperture from which it is separated by an angular distance of from 30° to 80° , it is evident that the shells exhibiting this character are adult, or, at least, have completed the growth of which they were capable. In certain species of *Dolium*, such as *D. fasciatum*, *D. zonatum*, *D. tessellatum*, *D. crosseanum*, the internal, and in some cases also the external thickening of the outer lip is invariably or almost invariably present in every specimen, quite irrespective of size, and, as it is quite inadmissible that all these specimens should have reached the termination of their growth, it is clear that, as in the case of many other gastropods, the animal is able to absorb the apertural structures at each successive phase of growth. The varicose specimens of *Dolium fasciatum* at present under consideration represent, therefore, individuals which, on approaching the final term of their growth, have lost the power of resorption; and, as the average size of these specimens is below that of the normally full-grown shell in which the pre-apertural varix is absent, they probably represent individuals the vitality of which has been impaired through insufficient nutriment or some other cause.¹ It seems evident that the majority of the specimens of *Dolium fasciatum* reach their final stage of growth without leaving, on the body-whorl, any trace of this pre-apertural varix.

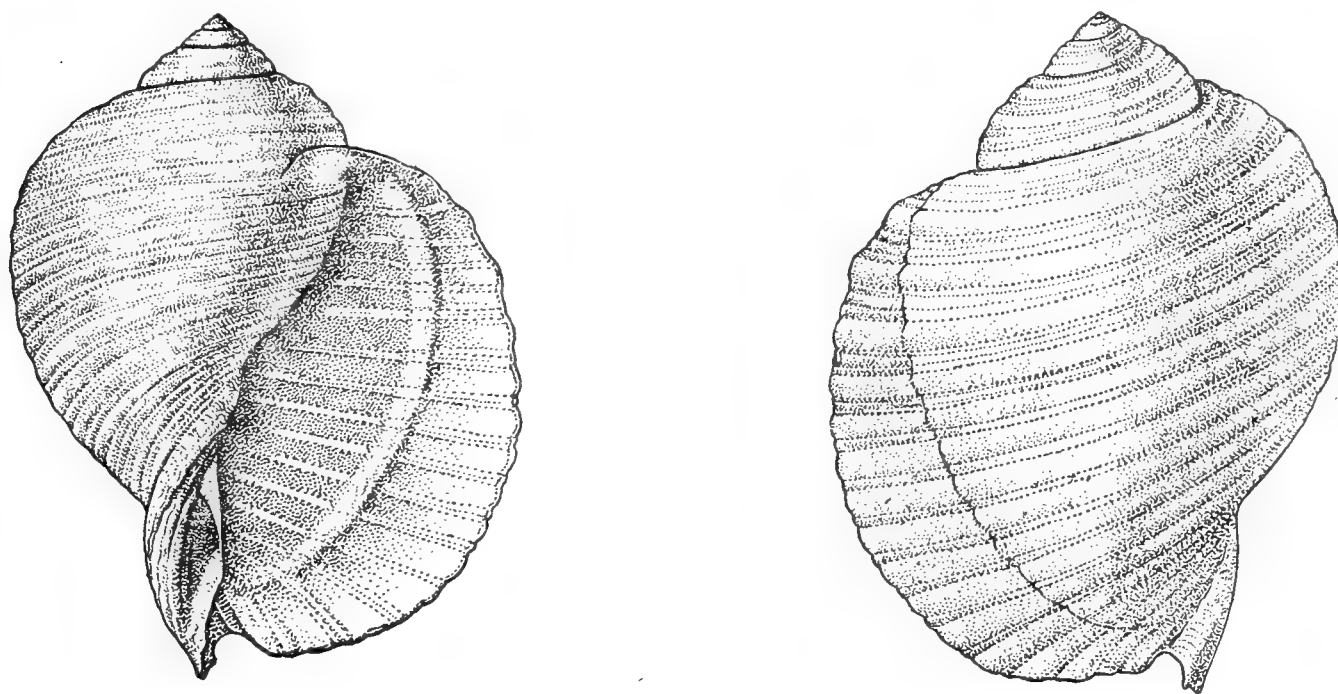
Nevertheless, the presence of this structure, though not constant, is of considerable interest as the first instance hitherto recorded of a feature generally absent from the Doliidæ, but characteristic of many Cassididæ; especially if we take into consideration the close relationship between *Dolium fasciatum* and the forms that have been referred to the sub-genus *Eudolium*, the resemblance of which to the Cassididæ has frequently been commented on, and is sometimes so pronounced that certain forms of this group have on several occasions been erroneously referred to *Cassidaria*.

The Indian Museum collections contain one more example of a *Dolium* exhibiting a supernumerary varix (text-fig., p. 147). This is a handsome specimen of *Dolium zonatum* from Hong-Kong, measuring no less than 142×112 mm.² The supernumerary varix is situated at an angular interval of about 55° from the outer lip whose edge has not yet received its final thickening, the growth of the shell being, apparently, still incomplete. In this species, the apertural thickening does not affect both the external and internal borders of the aperture as in *Dolium fasciatum*, but is developed only internally. Consequently, the supernumerary varix, in the present instance, is not conspicuous externally where it is indicated only by a slight swelling of the surface, bordered, on its forward side, by a linear groove. Internally it is very strongly developed and exhibits all the typical features that characterise the labrum of a full-grown specimen.

¹ Compare Dr. Annandale's remarks concerning the varix of *Hydrobioides nassa* from the Inlé Lake (*Rec. Ind. Mus.*, Vol. XIV, pp. 172-173), in which, however, the varix, as in certain other Gastropoda, is a constant adult character.

² It has not been possible to prepare a photographic reproduction of this fine specimen which came to notice only after the plates illustrating *Dolium fasciatum* had already been prepared.

In 1869 (*Journ. Conch.*, Vol. XVII, p. 228, pl. xii, fig. 1) Monterosato described a deep-sea form from the Mediterranean under the name of *Dolium crosseanum* referring it, in 1872 (*Notizie intorno alle Conch. foss. di Monte Pellegrino e Ficarazzi*, Palermo, 1872, p. 89), to a new genus *Doliopsis*, a name unfortunately preoccupied by Conrad in 1865 for a rather indistinct fossil, and for which, therefore, in 1889, Dall substituted *Eudolium* (*Bull. Mus. Comp. Zool.*, Vol. XVIII, p. 232). Tryon who was at first sceptical about the habitat of the shell suggested (*Man. Conch.*, Vol. VII, 1885, p. 263) that it might be a specimen of *Dolium zonatum* accidentally mixed with some Mediterranean shells. There is, however, not the slightest reason to doubt that the shell was obtained from a depth which may have been as great as 50 fathoms, by the Palermo fishermen who gave it to Monterosato. Nevertheless, Tryon's suggestion prompted by the general resemblance of the shell to *Dolium zonatum* appears to be



Shell of *Dolium zonatum* showing a supernumerary varix ($\frac{1}{2}$ nat. size).

to a great extent in keeping with its zoological affinities. I am not aware of the discovery of any further specimens in the Mediterranean, but the shell has been obtained at a number of spots in the West-Indies, from depths ranging between 90 and 300 fathoms and more.

It was described and figured as *Dolium bairdii* (*Trans. Conn. Acad.*, Vol. VI, p. 253, pl. xxix, fig. 2) by Verrill who precisely compared it with *Dolium zonatum*; its specific identity with *Dolium crosseanum* being recognised by Dall in 1889 (*loc. cit.*). The oligocene of Liguria, the miocene and pliocene of Piedmont, the pliocene of the Alpes-Maritimes and of the Rhone valley, and of Tuscany, contain fossil forms which are partly the obvious ancestors of *Dolium crosseanum*.

According to Cossmann's diagnosis in the *Essais de Paléoconchologie* (Fasc. V, 1903, p. 138), *Eudolium* is essentially distinguished from *Dolium*, *s. str.*, owing to its posteriorly slightly channelled aperture, its rugose columella, its shallow anterior

notch and the absence of an umbilicus, the latter, however, being a direct result of the feeble depth of the terminal notch, the accretions to which consequently do not produce the strongly twisted bulge, which leaves room for the formation of a more or less developed umbilicus amongst the species referred to *Dolium*, *s. str.* Cossmann also mentions, as a differential character, the tuberculation of the spire or body-whorl, but as the genotype, *Dolium crosseanum*, is without tubercles, this character cannot be strictly taken into consideration.

If we ignore the depth of the terminal notch and the consequent presence or absence of an umbilicus, we find, as regards the two other differentiating features, namely the slight posterior channel and the rugose columella, that *Dolium fasciatum*, *D. zonatum* and, amongst specimens of *Dolium tessellatum*, all those that are not adult, agree with *Eudolium* rather than with *Dolium*, *s. str.* Moreover, leaving aside again the fully adult specimens of *Dolium tessellatum*, these three species are further characterised by an internally thickened labrum with conspicuous denticulations, usually bifid, which is not distinctly developed in any of the other species hitherto referred to *Dolium*, *s. str.*, but which is invariably present in those that have been referred to *Eudolium*, as well as in the sub-genus or genus *Malea*.

If then we leave aside the characters furnished by the terminal notch and umbilicus, *Dolium fasciatum*, *D. zonatum* and *D. tessellatum* will have to be regarded as members of the group *Eudolium*, and, what the diagnosis loses in precision by the exclusion of the umbilical characters, it gains to an extent at least equal by including those of the outer lip. Now, the characters of the outer lip constitute precisely one of the features in which *Eudolium* recalls the Cassididæ, and, by adopting the grouping here proposed, we moreover include within *Eudolium* precisely both those species which occasionally exhibit a pre-apertural varix such as is observed in many Cassididæ.

The tubercles observed on some fossil forms of *Eudolium* are derived from a pronounced axial decoration analogous to the regularly distributed web of axial lines that characterises *Pirula*. Just as the characters of the aperture have prompted the erroneous reference of certain forms of *Eudolium* to the genus *Cassidaria*, so has this reticulated or tuberculated ornamentation, especially when combined with the elongate columella that distinguishes certain fossil forms, caused their erroneous reference to *Pirula*. The earliest portion of the spire following the protoconch generally shows a distinct web of regularly distributed lines of growth in most species of *Dolium*: but this character is particularly well marked in the case, precisely of *Dolium fasciatum* in which the axial lines are at first as thick as the average of the spiral ornaments, with which they combine to form so characteristic a network that the early part of the spire of *Dolium fasciatum* might be easily mistaken for that of a *Pirula* (Pl. ii, fig. 3c).

According to Dall (*Bull. Mus. Comp. Zool.*, 1889, Vol. XVIII, p. 223), the radula of *Dolium crosseanum* resembles that of the Cassididæ more than that of *Dolium*, *s. str.* Apparently the only species of *Dolium*, *s. str.* of which the radula has been figured is *Dolium perdix* (Troschel, *Gebiss d. Schneck.*, Vol. I, pl. xix,

fig. 3).¹ The radula of *Pirula*, judging from that of *Pirula reticulata* (Troschel, *op. cit.*, pl. xx, fig. 12), is essentially of the same type as that of *Dolium perdix*. Further observations on the radula of various species of *Dolium* would be of great interest.

In a general way, *Eudolium* seems to be somewhat of a synthetic group in which are united some of the characters of *Dolium*, *s. str.*, of *Malea*, of *Pirula* and of the Cassididæ. Nevertheless its relationship to *Dolium*, *s. str.* is of the closest character and entitles it to rank perhaps only as a section rather than a subgenus. It may here be mentioned that *Dolium cinguliferum* (Bronn) [= *Dolium fasciatum* (Borson) *non* Bruguière] of all species the one nearest related to the genotype *D. crosseanum* has been referred to *Dolium*, *s. str.* by Cossmann, who nevertheless gives a figure (*Essais Paléoconch.*, V, pl. vi, fig. 10) in which there is no indication of an umbilicus, while, on the contrary, Sacco has figured a specimen regarded as a variety also of *Dolium cinguliferum* (*Moll. terr. terz. Piem. e Lig.*, 1904, part XXX, pl. xxii, fig. 5) which shows distinct traces of the tubercles that characterise other forms of *Eudolium*. The sequel of these observations deals with the case of *Dolium tessellatum* which, until an advanced stage of growth, exhibits the essential characters of *Eudolium*, but finally, when fully adult, becomes similar to *Dolium*, *s. str.*, and I have suggested that this may afford some guide as to the derivation of the one group from the other, as is further indicated by their geological history. If we adopt the grouping here proposed, *Dolium*, *s. str.* is not known from any strata older than upper miocene, the only recorded fossil occurrences being in eastern countries, India and Java, while the group, at the present day, is mostly eastern. *Eudolium* already occurs abundantly in the oligocene, having been discovered, so far, in a fossil condition, only in Europe. *Pirula* is much more ancient and goes back to the cretaceous.

II.—THE SPECIFIC DISTINCTNESS OF *DOLIUM MACULATUM* (LAM.) DESHAYES AND *DOLIUM (EUDOLIUM) TESSELLATUM*, BRUGUIÈRE.

INTRODUCTION.

Amongst the beautiful illustrations to Reeve's monograph of the genus *Dolium* attention may particularly be drawn to four, of which the two first are referred to *Dolium fimbriatum*, Sowerby (species 3), the next one to *Dolium maculatum*, Lamarck (species 4), and another to *Dolium costatum*, Deshayes (species 8).

In his Manual (Vol. VII, page 264) Tryon rather emphatically asserts the specific identity of these three forms with which he further unites as synonyms a certain number of forms described as distinct by various authors. Tryon nevertheless maintains the three forms *costatum*, *maculatum* and *fimbriatum* as three separate varieties or races of a species *costatum*. No further discussion of Tryon's conclusions

¹ Troschel (*op. cit.*, Vol. I, p. 227) has briefly described, without figuring them, the radulae of two shells which he has referred to "*Dolium maculatum*, Lam. (= *tesselatum*, Encycl.) and *D. costatum*, Desh.," both of which seem to resemble closely that of *Dolium perdix*. The exact identity of the two shells in question is unfortunately, for the present, uncertain.

appears to have been attempted since the date of their publication, and not only have the three names *costatum*, *fimbriatum* and *maculatum* continued in use as those of distinct species, but the same is the case with some of the other names relegated by Tryon to the synonymy.

Having had occasion to study a large series of fossil specimens of *Dolium* from the later Tertiary formations of the Mekran, it became necessary for me to pay special attention to the related recent forms. From a perusal of the published information regarding the recent forms above alluded to, it was not found possible to decide definitely whether certain of the fossils under consideration were to be regarded as identical with some of them or rather to be interpreted as separate varieties or species. In order to establish a trustworthy comparison, it became necessary therefore to undertake a fresh study of the recent forms of which a rich series is preserved in the collections of the Indian Museum. The result of this study has been to confirm some of the identifications established by Tryon, though his final conclusions reach too far in one direction and not far enough in another; for, on the one hand, there is no difference (not even varietal) between *Dolium costatum* and *D. fimbriatum*, both of which represent a single species which should be known as *Dolium tessellatum*, Bruguière, while, on the other hand, *Dolium maculatum* represents a totally distinct species.

The supposed three forms are therefore reduced to two, which, nevertheless, under certain conditions are apt to exhibit a superficially deceptive resemblance to one another. Before discussing their differences and their zoological affinities, it will be useful therefore to give a detailed description of both these forms.

DESCRIPTIONS.

Dolium maculatum (Lam.) Deshayes.

(Pl. IV, figs. 1-3; pl. V, figs. 4-6.)

- 1685-1692. *Buccinum* sp., M. Lister, *Historia Conchyliorum*, pl. 899, fig. 19.
- 1757. "Le Minjac," Adanson, *Histoire Naturelle du Sénégal*, Coquillages, p. 109, pl. vii, fig. 6.
- ? 1758. *Buccinum dolium*, Linnæus, *Systema Naturæ*, Ed. X, p. 735.
- 1770. *Buccinum dolium*, Linn. sec. Huddesford, *Martini Lister, M.D., Historiæ sive synopsis methodicæ Conchyliorum et tabularum anatomicarum editio altera*, pl. 899, fig. 19.
- ? 1822. *Dolium maculatum*, Lamarck, *Hist. nat. des animaux sans vertèbres*, Vol. VII, sp. 3, p. 260.
- 1831-1837. *Dolium maculatum*, Lam., Kiener, *Iconographie des coquilles vivantes*, pl. iii, fig. 4.
- 1845. *Dolium maculatum*, Lam. sec. Deshayes, *An. sans vert.*, 2nd ed., Vol. X, p. 140.
- 1849. *Dolium maculatum*, Lam., Reeve, *Monograph of the genus Dolium*, sp. 4.
- 1857. *Dolium maculatum*, Lam., Küster, *Systematisches Conchilien-cabinet von Martini und Chemnitz*, Vol. III, 1st section, 2nd part, p. 73, pl. lxii, fig. 3.
- 1885. *Dolium costatum*, Menke, var. *maculata*, Lam., sec. Tryon, *Man. Conch.*, Vol. VII, p. 264.

Medium to large, globose, with depressed slightly conoidal spire measuring from one-seventh or even less to two-ninths of the total height.

The protoconch is relatively large, its visible portion attaining a diameter of four millimetres. This visible portion is depressed and turbinoid and consists of a very small, flattened, coiled nucleus and of three moderately convex whorls separated by somewhat grooved sutures; this visible portion constituting only the apical portion of the embryonic shell which, combined with the embedded portion, would exhibit, in this, as in all species of *Dolium*, a globose or ovoid outline; such embryonic shells having, on several occasions, been described as belonging to various genera (see Fischer, *Journ. Conch.*, Vol. XI, 1863, p. 147). The protoconch consists of a very highly glazed, transparent, amber-coloured, horny substance. As is usually the case with *Dolium*, the protoconch is filled with a secondary deposit of porcellaneous shell-substance supplying an additional support which has ensured the durability of this delicate structure. The protoconch is strongly oblique to the axis of the remainder of the shell.

The linear junction of the protoconch with the succeeding portion of the shell is straight and strongly oblique, antecurrent to the posterior suture and retrocurrent to the anterior suture. In full-grown specimens the protoconch is followed by three spire-whorls, the height of which does not exceed one-quarter of their width, the maximum width coinciding with the anterior margin. They are separated by channelled sutures. The first half of the first whorl following the protoconch is evenly convex, after which the whorls become angulated at about half their height. Posteriorly, a primary spiral rib borders the sutural channel, while another rather more prominent spiral rib accompanies the angulation. A third principal rib is usually visible, at least in the later portion of the spire, along the anterior margin of the whorls, though, in some specimens, owing to an extreme flattening of the spire, it is overlapped and concealed by the posterior edge of the next following whorl. There are even specimens in which the sinking of the spire is so exaggerated that the posterior edge of the body-whorl comes to coincide with the second primary rib. Each of the intervals between these main ribs carries several subsidiary spiral threads, three of which are usually particularly conspicuous, representing a median intercalary thread of the second order, flanked by two more threads of the third order; their respective thickness differing but slightly. There is, in addition, especially at the earlier stages, a more or less complete set of threads of the fourth order, many of which tend to disappear with increasing growth. Nevertheless, in many specimens, several of these threads of the fourth order may be continued throughout the spire and may reach the body-whorl together with the threads of the second and third orders, which invariably persist. Minor inconsistencies are occasionally observed. For instance, in the space anterior to the angulation, which is narrower than the space between the angulation and the circumsutural rib, one of the threads of the third order may be atrophied, so that this particular interval may carry only two conspicuous subsidiary threads instead of three. A singular peculiarity is observed in a specimen from Ceylon (or ? Kachh), in which the anterior thread of the third order in

this particular interval is of about the same thickness as the true median thread of the second order and is shifted quite close to it, so that they both together form a conspicuous pair occupying approximately the middle of the said interval, separated from one another at first by a minute thread of the fourth order. The two components of the pair gradually thicken and finally coalesce into one broad flat band, which remains somewhat bifid and is considerably wider than either of the two other main ribs (Pl. V, fig. 5). Nevertheless, throughout the numerous specimens that have been studied, the characters of the spire remain remarkably constant. The lines of growth are straight and strongly oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture. At the earliest stages of growth they form an extremely delicate web, intersecting the spiral ornaments, the crowded thin raised lines, much thinner than the three first orders of spiral ornaments, being distributed with the utmost regularity. With increasing growth, the lines become relatively less prominent and much less regularly distributed.

The large body-whorl constitutes the greater part of the shell. It is globose, almost spherical, exhibiting, on the right side of the shell, a continuous convex curvature which, on the left side, is interrupted by the zone of accretions of the deep terminal notch. Viewed dorsally, the zone of accretions is almost vertical at its rather abrupt junction with the anterior flattened termination of the basal convexity, and then assumes a convex outline becoming gradually more oblique in an anterior direction towards the right of the shell. The zone of accretions winds very steeply and bulges very feebly, which partly accounts for the narrowness of the umbilicus. Including the ornaments continued from the spire, and omitting the narrow ridge which posteriorly limits the terminal zone of accretions, the body-whorl carries ten or eleven primary spiral ribs. They are broad and ribbon-like though slightly convex. The two most posterior ribs, that is the circumsutural one and the one continued from the angulation of the spire, are narrower than the succeeding ones. The surface of the primary ribs frequently carries a variable number of fine raised spiral striations. Throughout the greater part of the shell the intervening spaces are much wider than the ribs, the two intervals continued from the spire, especially the most posterior one of all, being generally broader than the remainder. Towards the anterior termination, the primary ribs become more crowded and at the same time narrower, though, as the diminution in size does not exactly keep pace with the contraction of spacing, the three or four last intervals are of about the same width as the adjacent ribs or only slightly broader. The number of primary ribs remains exactly the same at all stages of growth: it is the same in small specimens of less than 30 millimetres in height as well as in full-grown shells of over ten centimetres. In those shells in which the spire develops an additional large rib by the coalescence of two subsidiary threads, the full-grown shell may apparently exhibit as many as twelve main ribs, but the supernumerary rib betrays its adventitious origin by its relative flatness, as well as by the disposition of the subsidiary threads in the two adjacent intervals in which they are fewer than in the true primary intervals, and lastly by the absence of the characteristic macula-

tions of the genuine primary ribs. The intervals between the primary ribs are decorated with subsidiary spiral threads. In the case of very small specimens, all the wider intervals may contain a complete representation of intercalary threads belonging to the second, third and fourth orders, the surface thereby acquiring a remarkably elegant appearance. Anteriorly, as the intervals become narrower, the intercalations may become reduced to the threads of the second and third orders, and finally to a single intercalary thread, while sometimes the most anterior of all the primary intervals, owing to its narrowness, is without any intercalation. These intercalary threads persist with increasing growth except those of the fourth order which generally fade away. The ornamentation remains quite unaltered throughout a wide range of successive stages of growth, but becomes somewhat altered in the case of large, fully adult specimens, in which some of the intercalary threads broaden out into flat bands resembling the primary ribs in shape, and filling a considerable portion of the available interstitial space. Various inconsistencies are observed in the development of these bands: in most instances they are due to the broadening of the median or principal intercalary thread, that is the thread of the second order, which then forms a band separated on each side from the neighbouring original primary ribs by a thin thread representing the original threads of the third order. At other times the broadening affects not only the median thread of the second order but also one of the flanking threads of the third order, and then the original primary interval may contain two adventitious broad flat bands which may become quite equal and may become shifted in such a way as to occupy a practically symmetrical position within the original primary space. Lastly, there are instances in which the broadening only affects one of the original threads of the third order, and the resulting adventitious band is situated quite unsymmetrically with respect to the original space. Threads of the fourth order are frequently revived on these adult specimens, but their reappearance is very inconsistent. They are apt rapidly to assume the same thickness as some of the threads of the second and third order, with which they may form close-set groups of two or three spiral threads. Owing to this reappearance of the threads of the fourth order, the most posterior primary interval (generally the broadest interval) carries variously disposed groups of spiral threads of various sizes, disposed differently in different specimens, the interpretation of which can only be deciphered by following them towards the apex along the spire. In a general way, these adventitious ornaments of the full-grown shell are very variable, and no two specimens are alike in this respect. They also commence to develop at various sizes, but usually when the shell reaches or slightly exceeds a diameter of 60 millimetres. Nevertheless, in one specimen from Balasore Bay (M4408), measuring 120 × 96 mm., apparently the largest in the collection, the adult characters of the ornamentation have scarcely commenced to appear. The terminal zone of accretions is posteriorly bordered by a narrow, feebly prominent, but sharp ridge, adjacent to which the accretions to the actual notch form a rather broad band, almost flat in some specimens, moderately convex in others, carrying crowded deeply concave lines of growth together with a few distant obscure spiral markings. On the somewhat

convex anterior zone intervening between this band and the umbilical portion of the columellar margin, the curvature of the lines of growth assumes a reversed direction, with the convexity turned anteriorly or forward, and there are two or three flat spiral bands, sometimes bifid, of about the same width as the intervening spaces. The lines of growth, throughout the body-whorl, are crowded, fine, inconspicuous, strongly oblique, anteriorly retrocurrent, straight until quite close to the anterior zone of accretions towards which they bend backwards and which they traverse with a strongly sigmoidal curve as above described.

The first half of the first whorl following the protoconch is of a uniform brown colour, after which the pigmentation becomes differentiated in such a manner that the primary ribs are white with chestnut patches at regular intervals, the intervening spaces assuming a porcelain-blue to porcelain-purple colour, best seen in the case of very fresh specimens. The contrasted whiteness of the non-maculated portions of the ribs is partly due to the opaque appearance caused by the thickening of the shell substance, while the bluish appearance of the intervals is partly caused by their thinner substance allowing the porcelain-like effect of translucency; nevertheless, whenever the specimens are sufficiently fresh, it can be readily ascertained that the colour effect is largely due to pigmentation of the intervals. The resulting appearance is well rendered in Sowerby's illustration in Reeve's Monograph. The maculations may be crowded as in the case of the specimen figured in Reeve's Monograph, or else much wider-spaced. They are particularly crowded in some specimens from the Andamans and from Balasore Bay, particularly wide apart in some specimens from Puri, but the spacing varies greatly amongst specimens from one locality, and even at different stages of growth in a single specimen. The maculations correspond more or less exactly from one rib to another according to the direction of the increments of growth. As a rule there are no maculations on any of the intercalary threads. In very exceptional cases they may be present, on the body-whorl, on some of the threads of the second order situated at about the widest part of the shell anteriorly to the level of the suture. The epidermis, when preserved, has the appearance of a thin layer of yellow varnish which does not interfere with the general appearance of the colour scheme. The pigmentation of the spire is invariably more pronounced than that of the body-whorl. The loss of vividness of the colour decoration with increasing growth in all forms of *Dolium* has already been commented on by Reeve (Monograph, sp. 11).

The large semi-circular aperture, the more interior part of which is salmon-coloured, becoming of a pure-white to bluish porcelain-like appearance towards the edge, is quite simple posteriorly, while anteriorly it is terminated by a deep obliquely disposed dorsal notch without any intervening canal. The columella forms an angle of 125° to 130° with the base of the penultimate whorl. It is slightly oblique anteriorly towards the left of the shell. Its general direction throughout the greater part of its length is straight with two slight bulges of which the more posterior one coincides with the inward extension of the terminal zone of accretions, the more anterior one with the sharply reflected edge of the columellar lip surrounding the narrow

umbilicus. Anteriorly to the umbilicus, the terminal portion of the columella is foliaceous and gradually contracts to a point at the anterior end of the shell, its edge being steeply oblique anteriorly towards the left. The columellar lip is not appreciable posteriorly and becomes distinct only anteriorly where it forms the thin flat lamina reflected over the narrow umbilicus. The outer lip is straight and strongly oblique. When fully developed it is bordered externally by a thin though well-defined incised straight line situated at about six millimetres from the actual edge of the aperture. Between this line and the actual edge, the surface expands somewhat outward, the spiral ornaments terminating in slight fimbriations. The external limiting line approximately coincides internally with a slight swelling which, in some specimens, is bifid. Owing to the thinness of the shell, the external spiral ornaments are reproduced on the inner walls in reversed order of relief as is usual in shells of this genus. On crossing the internal swelling of the fully developed outer lip these spiral ornaments remain unaltered in character and do not give rise to apertural tubercles as is frequently the case on the corresponding portion of other species of *Dolium*. In the great majority of specimens, even those of the largest size, the outer lip terminates in a perfectly simple edge.

Variability.—This remarkably abundant shell is particularly constant in all its characters. The only variable features are the more or less sunken disposition of the spire, inconsistencies in the intercalary spiral decoration especially on reaching the adult stage, the variable degree of crowding of the maculations, and slight differences in outline of the body-whorl which may tend to become a little more spherical or spheroidal or else slightly ovoid. These variations are never correlated, but all occur quite independently of one another, so that there is no distinct tendency towards the formation of races or varieties. The most conspicuous abnormality in the ornamentation is that caused by the adventitious formation of a supernumerary rib as described above in the case of a specimen from Ceylon (or ? Kachh). It is the only available specimen exhibiting this peculiarity which perhaps represents merely an individual aberration.

Dimensions :—

Height	..	..	..	114 mm.	69 mm.
Thickness	..	..	..	93 "	55 "
Height of spire	..	..	..	25 "	10 "
Height of body-whorl	..	..	..	103 "	64 "

The larger specimen is from Ceylon (or ? Kachh), the smaller one from Puri.

Occurrence.—This is the commonest species of *Dolium* along the Indian coasts. It abounds wherever the sea-floor consists of fine soft sand or mud. According to Melville and Abercrombie (*Mem. and Proc. Manch. lit. and Phil. Soc.*, 4th ser., Vol. VII, 1893, p. 32) it is a deep-sea form. Nevertheless the shells are frequently washed on to the beach.

Owing to uncertainties in the identification of this shell and of *Dolium tessellatum*, there is some difficulty in ascertaining the limits of its distribution from published accounts. Judging from the material preserved in the collections of the Indian

Museum it is found all along the coasts of peninsular India from Kachh on the western side to Balasore in the east, and also along the coast of Arakan and the Malay Peninsula. One specimen is labelled as coming from as far east as Amboina.

In a fossil condition, it is known from the pliocene of the Mekran coast and from the post-tertiary formations of the Pulicat lake.

The discussion of the relationship of this shell to other species will be deferred until the completion of the description of *Dolium tessellatum*.

***Dolium (Eudolium) tessellatum*, Bruguière.**

(Plate VI, fig. 7; pl. VII, figs. 8–10; pl. VIII, figs. 11–13.

- 1789. *Buccinum tessellatum*, Bruguière, *Encyclopédie méthodique*, Vol. VI, sp. 4, pp. 236, 246, pl. 403, figs. 3a, b.
- 1790. *Dolium tessellatum*, Bruguière, *Encyclopédie méthodique*, pl. 403, figs. 3a, b,
- 1823. *Dolium fimbriatum*, Sowerby, *Genera of Shells*, fig. 2.
- 1830. *Dolium costatum*, Menke, *Synopsis methodica*, 2nd ed., p. 63.
- 1831–1837. *Dolium fasciatum*, Brug. var. *sec.* Kiener, *Iconographie des Coq. viv. Dolium*, pl. iv, fig. 6.
- 1831–1837. *Dolium variegatum*, Lam. (*junior*) *sec.* Kiener, *Icon. des Coq. viv.*, pl. ii, fig. 3.
- 1845. *Dolium costatum*, Deshayes, *An. sans vert.*, 2nd ed., Vol. X, p. 144.
- 1845. *Dolium minjac*, Adanson *sec.* Deshayes, *An. sans vert.*, 2nd ed., Vol. X, p. 145, no. 9.
- 1845. *Dolium ampullaceum*, Philippi, *Zeit. Mal.*, p. 147.
- 1849. *Dolium fimbriatum*, Sow., Reeve, *Monograph of the genus Dolium*, sp. 3
- 1849. *Dolium costatum*, Desh., Reeve, *Monograph of the genus Dolium*, sp. 8.
- 1849. *Dolium ampullaceum*, Phil., *Abbild. III*, 4. *Dolium*, p. 12, pl. ii.
- 1857. *Dolium costatum*, Mke., Küster, *Conch. Cab. von Martini und Chemnitz*, Vol. III, 1st section, 2nd part, p. 61, pl. lvi, fig. 3; pl. lvii, fig. 3.
- 1857. *Dolium Lischkeanum*, Küster, *Conch. Cab.*, p. 71, pl. lxii, fig. 1.
- 1857. *Dolium fimbriatum*, Sow., Küster, *Conch. Cab.*, p. 72, pl. lxii, fig. 2.
- 1879. *Dolium costatum*, Desh., Martin, *Die Tertiärschichten auf Java*, p. 40, pl. vii, figs. 9, 10.
- 1899. *Dolium costatum*, Desh., Martin, *Samml. des geol. Reichsmus. in Leiden*, new series, Vol. I. p. 161, pl. xxv, figs. 371–373.

Medium to large, globose, slightly ovoid, with slightly conoidal, sometimes conical depressed spire measuring from two-ninths to three-tenths of the total height.

The protoconch is relatively small, the diameter of the visible portion not exceeding three millimetres. It consists of a horny transparent substance of dark-brown colour. The internal secondary infilling of porcellaneous shell-substance does not reach the apex, so that the minute, depressed, coiled nucleus, lacking internal support, is almost always broken off. The visible portion of the protoconch is rather prominent, semi-naticoid, that is with the appearance of a half-embedded *Natica* and includes three convex whorls separated by very narrow, slightly grooved sutures. The protoconch is slightly oblique to the axis of the remainder of the shell. The line of junction of the protoconch with the remainder of the shell is slightly curvi-

linear with forward facing convexity, and is oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture.

The protoconch is followed by three to three and a half convex spire-whorls, separated by slightly sunken sutures. Their height varies from two-ninths to a little over one-quarter of their width, the maximum thickness coinciding with the anterior margin. The whorls usually exhibit four ribbon-like main ribs, considerably narrower than the intervening spaces which are slightly concave. The most posterior main rib, which is narrower than the others, encircles the circumsutural depression. The most anterior rib coincides with the anterior margin and is frequently more or less overlapped by the posterior edge of the next following whorl. In rare instances, the spire is so much sunken that the posterior edge of each whorl reaches the level of the third primary rib of the preceding whorl. The intervals between the primary ribs may be approximately equal, though usually the most posterior interval is somewhat wider than the remainder. On the first whorl following the protoconch, each interval usually carries three delicate subsidiary spiral threads, namely a median thread of the second order flanked by two threads of the third order. Occasionally one of the threads of the third order may be atrophied or indistinct. On the second whorl, the threads of the third order disappear, leaving only, in each interval, the median thread of the second order which also becomes gradually thinner and indistinct with increasing growth. On the third whorl all the threads of the second order may likewise disappear, leaving the intervals perfectly smooth, but there usually subsists a more or less distinct remnant of the line intersecting the most posterior interval, usually reaching even to the body-whorl. A number of extremely fine spiral lines are usually observed on the surface of the main ribs. The extremely fine crowded lines of growth, especially distinct and regular on the first whorl following the protoconch, are practically straight and strongly oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture.

The large body-whorl constituting the greater part of the shell is always strongly inflated and globose, and may be almost spherical, but is more usually distinctly ovoid. On the right side of the shell its convexity is continued as far as the anterior termination, while on the left side a shallow concavity intervenes between the main basal convexity and the zone of accretions to the very deep dorsal notch, whose outline, on the left side of the shell, viewed dorsally, is steeply oblique anteriorly towards the right and slightly convex. The actual edges of the notch are slightly reflected outward. Ventrally, the steeply winding anterior edge of the terminal zone of accretions is bounded by the foliaceous termination of the columella and columellar margin, with the formation of a narrow umbilicus. Including the spiral ornaments continued from the spire, and irrespective of the ridge forming the posterior edge of the terminal zone, the body-whorl, in the case of small specimens measuring less than 35 mm. in height, carries twelve primary ribs. In specimens measuring from 35 to 45 mm., the number of primary ribs is usually thirteen. In the majority of specimens ranging from 45 to 100 mm., the number of primary ribs is fourteen, though, occasionally, amounting only to thirteen. At still

larger dimensions, the primary ribs may increase to as many as sixteen. The increase is due to the appearance, one at a time, of an additional rib at the anterior limit of the convexity of the base, just along the edge of the terminal zone of accretions. The ribs are ribbon-like, and become more crowded and somewhat narrower towards the anterior limit of the base, in consequence of which the intervals, which throughout the greater part of the body-whorl are broader than the ribs, become, towards the anterior extremity, of about the same width as the ribs or narrower. As in the case of the spire, the ribs carry delicate spiral lines. In the great majority of specimens the intervals are quite without any spiral ornaments, except usually the most posterior and broadest interval, which is generally bisected by a thin remnant of the median subsidiary thread continued from the spire, though there are specimens in which even this last remnant has disappeared. In the case of very young specimens of less than 30 mm. in height, every interval throughout the body-whorl is bisected by a very thin intercalary thread.¹ With the usual exception, as already noticed, of a feeble remnant in the most posterior interval, all these subsidiary threads disappear before the shell has reached a height of 30 mm. Amongst the series of specimens in the Calcutta collection, the sculpture of the body-whorl remains perfectly unaltered up to a total height of 100 mm. It is only in quite adult specimens of still larger size that the sculpture enters upon a new phase through the re-appearance of intercalary ribs, which may broaden until they fill almost the whole of the available interstitial space, and assume an appearance almost identical with that of the original primary ribs. On the later part of the body-whorl of the largest specimen in the Calcutta collection, the seven first intervals, counting from the posterior edge of the body-whorl, each carry an intercalary rib. The eighth, ninth, and tenth are plain, but an intercalary rib also appears in the eleventh. In the large individual illustrated in Reeve's monograph (fig. 3a), some of the intervals carry two subsidiary ribs. The scarcely bulging, torose, steeply winding zone of accretions is posteriorly bordered by a very thin, narrow, sharply defined ridge. It is divided into two sub-equal portions, a posterior one corresponding with the accretions of the deep indentation of the notch, across which the lines of growth are deeply concave, and an anterior portion corresponding with the accretions of the anterior border of the notch and anterior termination of the shell, across which the lines of growth are convex. This anterior portion carries three or four spiral ribs. The band corresponding with the accretions to the notch may also carry spiral ribs, especially in the case of small specimens, but they are less prominent than those of the anterior sub-zone, and, in many instances, are represented merely by some obscure distant spiral lines. The anterior termination of the anterior sub-zone, forming the anterior termination of the shell, when well preserved, is foliaceous and somewhat palmately expanded. The thin lines of growth, over the greater part of the body-whorl, are strongly oblique and anteriorly antecurrent, and

¹ Martin has figured a fossil specimen from the pliocene beds of Java (*Samml. des geol. Reichs-Museum in Leiden*, new series, Vol. I, pl. xxv, fig. 372), referred to *Dolium costatum*, and measuring about 30 mm. in height, in which the intercalary median thread is faintly visible in several of the intervals of the body-whorl.

are practically straight throughout the greater part of their course, bending backward anteriorly only in the immediate neighbourhood of the terminal zone of accretions which they traverse, as above described, with a pronounced sigmoidal flexure.

The large semi-circular to semi-oval aperture is anteriorly terminated by the deep, strongly oblique dorsal notch, without any intervening canal. Its posterior termination is slightly though distinctly channelled in the case of immature specimens, but becomes simple when the shell is quite adult. The columella which is, on an average, approximately straight, and slightly oblique anteriorly towards the left of the shell, forms an angle of about 120° with the base of the penultimate whorl which it joins rather abruptly. It exhibits two rather feeble winding bulges of which the more posterior one coincides with the inward extension of the zone of accretions, while the more anterior one represents the junction with the reflexed edge of the columellar lip. In the case of small and medium specimens, the anterior part of the columella carries a number of rugosities some of which are sometimes internally continued as thin spiral folds. When the specimens attain a height of about 90 mm., the columellar rugosities become indistinct, while, in the case of fully adult specimens, they entirely disappear, and the columella is quite smooth. The anterior thin foliaceous terminal portion of the columella, anteriorly to the very small umbilicus, is very narrow. The columellar lip spreads rather widely over the ventral surface of the base. It is mostly so thin as not to interfere with the sculptured and coloured decoration of the base of the penultimate whorl. Nevertheless, in the case of immature specimens its marginal portion, of a glossy porcellaneous texture, is frequently sufficiently thickened to become opaque white, the actual edge adhering fairly closely to the more posterior portion of the convexity of the base, but becoming semi-detached or even detached on approaching the terminal zone of accretions. Anteriorly to the terminal zone of accretions it surrounds the small umbilicus and joins the columella. The thickened edge gradually becomes less distinct as the specimens grow larger. In the case of full-grown specimens the greater part of the columellar lip ceases to be appreciable, the anterior termination, where it surrounds the umbilicus, alone remaining distinct. In a few specimens, at the posterior termination of the columellar lip, there is a feebly prominent though distinct oblique ridge which contributes to define the shallow posterior channel. The outer lip is straight and strongly oblique. When its structure is characteristically developed, it is externally thickened and expanded, its edge is deeply fimbriated owing to the intervals between the ribs extending much further forward than the ribs themselves, while internally it is thickened and denticulate. All these characters, external expansion, marginal fimbriations, internal thickening and denticulations, are as a general rule most typically developed in small and especially in small-medium specimens, especially those measuring from 55 to 75 mm. in height. In exceptional instances they are still quite typically developed in specimens measuring as much as 80 mm. in height, but as the shell exceeds these dimensions they become more and more indistinct. When the shell is quite adult, the external thickening and expansion, the marginal fimbriations, the posterior channel, and the internal denticulations entirely

disappear, and there only remains a slight internal thickening close to the edge. As is usual in the shells of this genus, the external ornamentation is reproduced in the interior of the shell in inverted relief, so that it is the sunken intervals or grooves of the outer surface which assume the appearance of ribs on the internal walls. On crossing the internal marginal swelling of the labrum, in those specimens in which the apertural features are characteristically developed, each of these internal ribs usually develops a pair of elongate denticulations or ridges which terminate externally against the fimbriated digitations of the edge. Sometimes the most anterior internal rib develops but a single denticulation or ridge, while frequently some of the broader posterior internal ribs (corresponding to the broad posterior intervals of the outer surface) may give rise to three denticulations, or, occasionally, to as many as four.

The first whorl following the protoconch is dark brown, though not so dark as the protoconch itself. It is not uniformly tinted, the depth of the colour decreasing considerably towards the posterior margin. On the following whorl the broad spaces between the primary ribs are usually of a reddish or purplish, or sometimes bluish tinge, while the main ribs themselves are white or yellowish-white maculated with yellowish-brown. The same scheme may be continued on the third whorl with a paler tint for the intervals, and may also extend over the entire body-whorl, the intervals becoming still paler, until with increasing growth they may become quite white. In certain cases, the ribs, over the whole body-whorl, may maintain the appearance of white bands with yellow spots (as in the type of *Dolium lischkeanum*, Küster), while in other instances their coloured decoration may gradually disappear, and, when the colour of the intervals has likewise vanished, the entire body-whorl may be white. In other instances, the yellow tinge of the maculations gradually spreads along the intervening portions of the ribs until all the spots coalesce, and the ribs assume the appearance of continuous yellow bands. When, as is frequently the case, the intervals have become nearly or quite colourless, the general colour scheme becomes reversed in this sense that the ribs, instead of appearing as light spotted bands against a darker ground, become darker bands against a lighter ground. This is the appearance exhibited by Kiener's *Dolium fasciatum* var. Lastly, there are specimens in which the greater part of the shell is almost uniformly tinted of a rich orange or burnt-sienna colour, deepening to brown towards the apex. In large thoroughly adult specimens, the intercalary ribs assume the same maculated decoration as the original primary ribs. The deeper internal portion of the aperture is of a yellowish or brownish tinge. The columella, the thickened portions of the columellar lip and inner portions of the outer lip are white and porcellaneous.

Dimensions.—The following measurements refer to a series of specimens obtained from the Andamans, with the possible exception of No. 7, the exact origin of which is uncertain. No. 5 is from the South Andaman.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Height ..	122 mm.	95 mm.	72 mm.	61 mm.	54 mm.	37 mm.	34 mm.
Thickness ..	99 "	73 "	57 "	50 "	38 "	28 "	28 "
Height of spire	29 "	27 "	22 "	16 "	15 "	10 "	8 "

Height of body-whorl	(1)	(2)	(3)	(4)	(5)	(6)	(7)
..	105 mm.	84 mm.	64 mm.	56 mm.	49 mm.	33 mm.	32 mm.

The next specimen, of uncertain origin, is remarkable for its exceptionally sunken spire :

Height	..	..	..	..	70 mm.
Thickness	..	..	..	..	58 „
Height of spire	..	..	..	..	16 „
Height of body-whorl	..	..	..	..	65 „

Variability and Development.—This shell is even more constant in its characters than the previously described *Dolium maculatum*, the only distinctly variable features being those of the colour scheme. As regards the more essential characters, one merely observes slight differences in the more or less sunken disposition of the spire, and the more or less distinctly spherical or ovoid outline of the body-whorl.

At the same time, some very remarkable differences are observed in the appearance of the shell at different stages of growth, especially with reference to the apertural characters. While, in the case of fully adult specimens, the aperture is posteriorly simple, the outer lip undifferentiated, and the columella smooth, the shell at early and intermediate stages of growth has a strongly fimbriate and denticulate outer lip, a posteriorly slightly channelled aperture, and a distinctly rugose columella. Whilst the adult shell is in every sense a typical *Dolium*, the posterior channel and especially the rugose columella of the immature specimens recall the sub-genus *Eudolium*. The external and internal thickenings, marginal fimbriations, and internal denticulations of the aperture, the posterior apertural channel, the thickening of the columellar lip and the rugosities of the columella observed in these immature specimens of *Dolium tessellatum* agree in every respect with the corresponding features observed at all stages of growth in *Dolium fasciatum* (Brug.) which there is reason to refer to the subgenus *Eudolium*, and readily account for Kiener's interpretation of such specimens of *Dolium tessellatum* as representing a variety of *Dolium fasciatum*. The development of *Dolium tessellatum* is of great interest as suggesting the possible derivation of the more typical forms of *Dolium* from *Eudolium*, especially as, so far as can be judged from the information at present available, *Eudolium* is geologically more ancient.

Occurrence.—With the exception of a few individuals of uncertain origin, all the specimens in the collection of the Indian Museum are from the Andamans and Nicobars. Shells certainly referable to this species have been obtained from the Malay Islands and Japan.

In a fossil condition, the species is known from the upper miocene and pliocene of Java, and from the pliocene of the Mekran.

COMPARISON OF *DOLIUM MACULATUM* AND *DOLIUM TESSELLATUM*.

Remarks on the Taxonomy.—Owing to the hopelessly confused synonymy of the forms under consideration, the task of discovering suitable names for the two species above described has proved extraordinarily troublesome.

Many of the works containing the more or less recognisable figures cited by the earlier authors are, unfortunately, not available in India. Nevertheless there is not the slightest doubt that they include representatives of both the species above described in detail, while the diagnoses are generally far too concise to elucidate the confusion which undoubtedly exists in the synonymy.

Amongst the appellations for which any definite claim can be put forward to be used as specific names, the oldest is probably Adanson's "le Minjac" (1757). Deshayes regarded the figure as representing the same species as Sowerby's *Dolium fimbriatum*, and it would correspond therefore with *Dolium tessellatum* as above described. Deshayes has therefore adopted for this species the name *Dolium minjac*, Adanson. Adanson, in his synonymy, refers to Lister's figure which represents *Dolium maculatum*, and to Rumphius' which represents *D. tessellatum*. The description is not sufficiently detailed for establishing which species is meant. The body-whorl is said to carry fourteen ribs, which, in specimens of the size of the one referred to by Adanson, namely two inches (about 50 mm.), might suit *D. tessellatum*; only, as the ribs, over the widest part of the shell, on the figure illustrating the dorsal aspect, are shown of two alternating sizes, of which only the thicker ones carry spots, it seems obvious that the figure represents *D. maculatum*, and not *D. tessellatum* as conjectured by Deshayes. As it is, Deshayes seems somewhat uncertain as to whether Adanson's figure represents Sowerby's *Dolium fimbriatum* or Lamarck's *Dolium variegatum* (*Ansans vert.*, 2nd ed., p. 143, footnote). The locality, Senegal, is improbable, more so even for *Dolium tessellatum* (Brug.) than for *Dolium maculatum*, Deshayes, since, in the Indian Ocean at any rate, the latter extends much further west.

The authority next in date is Linnæus, in the 10th edition of the *Systema Naturae*, published in 1758, in which d'Argenville's genus *Dolium* is merged into *Buccinum*, and a species recorded as *Buccinum dolium*. The 10th edition is not available in India. The synonymy as given by Gmelin in the 13th edition includes the following citations:—

Rondelet, Testacea, 106, *Cochlea rugosa*.

Rumphius, Mus., pl. 27, fig. A, *Cochlea striata* s. *olearia*.

Calceol. Mus., 30, pl. 41.

Lister, Conch., pl. 899, fig. 19.

Bonann. Recr., 3, figs. 16, 17, 25.

Mus. Kircher, 3, figs. 16, 17, 28.

Gualtieri, Test., pl. 39, fig. E.

D'Argenville, Conch., pl. xvii, fig. C.

Seba mus. 3, pl. 68, figs. 9, 11; pl. 70, figs. 1, 2, 5.

Mus. Gottwald. pl. 27, fig. 185b, fig. 188b.

Knorr, Vergn., 3, pl. viii, fig. 4.

Martini, Conch., pt. 3, pl. 116-118, figs. 1072-1075, 1082.

Out of the twelve works mentioned in this list, only five are accessible in Calcutta, namely those of Rumphius, Lister, Seba, Knorr, and Martini.

The shell figured by Rumphius clearly corresponds with that here described

as *D. tessellatum*. The library of the Geological Survey contains the second edition of Lister's *Conchology*, from which it may be recognised that the figure mentioned in the synonymy represents a shell of *Dolium maculatum*, the drawing of which has been badly interpreted by the engraver; so much so that, for anyone who had not specially studied the species, the figure might just as well be taken for one of *Dolium tessellatum*, while the short description is too ambiguous to be of any help. In Seba's work, figures 9 to 11, plate lxviii, represent *Dolium maculatum*, while figures 1 and 5, plate lxx, represent *D. tessellatum*. Figure 2, plate lxx, is too indistinct for identification and possibly represents a shell of another genus. Knorr's figure undoubtedly represents *D. tessellatum*. In Martini's work, figures 1072 and 1082 undoubtedly represent *D. tessellatum*, while figures 1073 and 1074 undoubtedly represent *D. maculatum*. The shell represented in figure 1075 is immature and cannot be so securely identified, though it is probably referable to *D. maculatum*.

Amongst later authors, the one who has most fully dealt with the iconography of the works under consideration is Küster by whom the figures published by Rumphius and by Knorr are referred to *Dolium fimbriatum*, that is to the species above described as *Dolium tessellatum*; while the figures in the works of Gualtieri and d'Argenville are regarded by the same authority as representing *Dolium maculatum*.

In conclusion, it is abundantly clear that the figures referred to in Gmelin's synonymy are about equally divided between the two species above described as *D. maculatum* and *D. tessellatum*. The synonymy quoted by Linnæus and Gmelin does not help us therefore in determining which shell was intended in the *Systema Naturæ*. The diagnosis, unfortunately, does not help us any further. It is as follows: "testa ovata cincta sulcis remotis: cauda prominula," and is therefore totally insufficient to recognise which species is meant.

In 1770, William Huddesford, in the second edition of Lister's *Conchology*, adopted the name *Buccinum dolium* for the figure referred to in the *Systema*. There should be here no room for any ambiguity. Unfortunately, as already mentioned, both the engraving and the diagnosis are very unsatisfactory and would not of themselves materially afford any help to the identification of the species.

Bruguière, in 1789, in describing the "buccin cordelé," gives to a large extent the same synonymy as Linnæus for *Buccinum dolium*. There is nevertheless an important divergence in the reference to Martini's work, from which Linnæus has quoted no less than five figures of which two only are selected by Bruguière as representing his *Buccinum tessellatum*. These are figures 1073 and 1082, the second of which, forty years later, was selected by Menke as the type of *Dolium costatum*.

Bruguière's descriptions are of an entirely different type from Linnæus' diagnoses, and, although the plates illustrating the *Encyclopédie Méthodique*¹ are not avail-

¹ This is not the famous, though frequently inaccurate original edition of the "*Encyclopédie*," but the magnificently planned 2nd edition, initiated in 1782 under the most distinguished auspices, the several parts being entrusted to the most accomplished and learned men of the age. The publication of this stupendous work had been so organised as to ensure its completion in 1792. The revolution unfortunately robbed the scheme of the greater portion of its enlightened and distinguished patronage, after which the publication lingered in a precarious and impoverished condition until 1832, when it was finally interrupted and remained unfinished.

able in Calcutta, the description of his *Buccinum tessellatum* is so complete and precise as to render the illustrations superfluous.

Indeed, but for the praiseworthy exception of a small number of naturalists, Bruguière, in the admirable accuracy and fulness of his descriptions, is more than a century in advance of his successors.

As the present enquiry has not for its object to resuscitate an obscure obsolete name in place of others in general use and of well-established meaning, but as it is merely an attempt to select a suitable name amongst half a dozen or more the present usage of which is involved in the utmost confusion, it will perhaps not appear superfluous if Bruguière's description is here reproduced *in extenso* before analysing it. The sentences are numbered for the convenience of reference.

(1) "Celui-ci ne cède pas en beauté au *Buccin perdrix*, mais il lui est très-souvent inférieur par son volume; celui dont je donne la description est étonnant par sa grandeur et par sa belle conservation, il surpasse de plus d'un tiers leur proportion la plus ordinaire; il a quatre pouces six lignes de diamètre, la longueur de son ouverture est de trois pouces sept lignes, et sa largeur d'un pouce dix." (2) "Sa spire est composée de sept tours complets, qui sont garnis de côtes élevées, convexes, écartées, au nombre de quatorze sur le tour inférieur, et de quatre seulement sur ceux du haut; ces côtes sont séparées par des sillons plats, ordinairement plus larges qu'elles, qui sont quelquefois marqués au milieu par une ligne élevée qui suit leur direction." (3) "Cette coquille, ainsi que la précédente" (*Buccinum perdrix*) "ne forme point de canal enfoncé à la jonction des tours, ils appuient au contraire carrément l'un sur l'autre, et laissent à leur jonction un rebord applati." (4) "Son ouverture est très grande et cannelée dans l'intérieur." (5) "La lèvre droite est peu évasée et dentée pendant la jeunesse, de manière que chaque côte est terminée par deux lignes élevées qui disparaissent tout-à-fait quand la coquille est parvenue au volume de celle dont je donne la description." (6) "La lèvre gauche ressemble à celle des espèces précédentes par son peu d'épaisseur, qui est telle que, quoiqu'elle recouvre les côtes du ventre de la coquille, elles n'en sont pas moins saillantes pour cela." (7) "La columelle est formée comme dans le *Buccin cannelé*, elle est tordue en spirale et garnie à l'extérieur des côtes longitudinales jusqu'à l'échancrure de la base; l'ombilic est situé comme dans cette coquille, mais il a un peu moins de largeur et moins de profondeur." (8) "Ce *Buccin* est ordinairement blanc à l'extérieur ou de couleur fauve, et ses côtes sont le plus souvent marquées de grandes taches fauves, jaunes ou orangées, qui sont presque toujours effacées sur les quatre ou cinq tours plus anciens." (9) "Mais ces taches manquent quelquefois tout-à-fait, et la coquille est alors blanchâtre ou d'une teinte faible de couleur de chair; on en connaît aussi des variétés qui sont toute brunes, d'autres dont les côtes sont un peu élevées, plus écartées et presque aigues, dont la couleur tire sur le gris ou le cendré; il ne doit pas paraître étonnant que cette coquille offre des variétés si remarquables, puisque son espèce occupe une étendue immense sur la surface de la terre." (10) "Linné a dit qu'on la trouvait sur les côtes de la Sicile et de la Barbarie; Bonanni dit de même, mais il la reçut aussi des Indes orientales; M. Adansson la trouva au Sénégal;

Rumphius a l'île d'Amboine ; Martini l'indique aux îles de Tranquebar ; et Petiver a l'île de Luçon, l'une des Philippines."

We may now add a few comments on this admirable description.

(1) From the very first sentence, Bruguière, in accordance with the best models of modern descriptions, adopts the practice, too often neglected even by modern writers, of giving detailed measurements of the species. Judging from the figures quoted, the average diameter of large specimens should be three inches, or about 75 mm., which agrees with what is generally observed in the species above described as *Dolium tessellatum*, while the exceptionally fine specimen specially selected by Bruguière for description measured four and a half inches, or about 115 mm. in diameter, a size probably never attained, so far as is known, by *Dolium maculatum*, and only inferior by about 20 mm. to that of the magnificent specimen figured in Reeve's monograph as *Dolium fimbriatum*. The most essential point with reference to the present enquiry is that the detailed measurements given by Bruguière are those of the particular specimen about to be described. Clearly then, this description is not a generalised diagnosis built up from a number of specimens or uniting the separately published features of previous descriptions. It is a detailed description of a single specimen, and obviously therefore cannot refer to more than one species. Whatever may be that species, it is clear that the merest glance through the very first sentence suffices to dispose of the totally undeserved criticism of Reeve, of Küster, and of Tryon, regarding the alleged composite character of *Dolium tessellatum*.

(2) The dimensions recorded in the first sentence already exclude almost all possibility of referring Bruguière's type to *Dolium maculatum*. The number of ribs as recorded in the second sentence irrevocably confirms its attribution to the shell described in the present work as *Dolium tessellatum*; for even taking into account any possibility, however improbable, of mistaking, on the body-whorl, some of the ribs of the second order for primary ribs, the number recorded on the spire-whorls, namely four, settles once for all the specific attribution of the shell under consideration. *Dolium tessellatum*, as understood in the present work, does not always exhibit as many as four ribs on the spire-whorls, but *Dolium maculatum* never shows more than three; and it is beyond all possibility of a doubt that the type described by Bruguière is *Dolium tessellatum* as here interpreted. The shape of the ribs, the shape and size of the intervals, the occasional presence of a median line, and the number of ribs on the body-whorl, as described by Bruguière, are all in total agreement with this interpretation.

(3) This sentence refers to the absence of a deep sutural channel such as characterises *Dolium galea* or *D. olearium*. Sentence (4) needs no comment.

(5) Not only has Bruguière given a perfectly precise description of the characters of the labrum, but he has recorded with admirable lucidity the history of its development throughout the successive stages of growth of the shell. It is unnecessary to comment on the wonderful insight of the great naturalist at a period when the science of zoology was still in its formative period. It is nevertheless astonishing that so remarkable an observation should have passed unnoticed by all his

successors who have either paid no attention to the ontogeny of the shell, or else have totally misinterpreted its mode of growth.

Sentences (6) and (7) do not call for any special comment.

(8) and (9) The description of the colouring is remarkably complete, precise, and consistent, and in several points is opposed to what is observed in *Dolium maculatum*; as for instance the remark that the maculations are usually less distinct on the early part of the spire than at succeeding stages, just the opposite of what is usually seen in *Dolium maculatum*; or again the occurrence of non-spotted specimens, frequent in the species described by Bruguière, not known in *Dolium maculatum*; also the occurrence of specimens uniformly tinted brown, which again entirely excludes *Dolium maculatum*.

(10) The distribution mentioned is to a large extent incorrect; but if the name were to be rejected on that account, it would be necessary to reject also for that same reason an enormous proportion of the species established by Linnæus, Gmelin, Lamarck, Sowerby and even Reeve, as, in former times, the localities from which objects of Natural History were obtained were but too often incorrectly recorded.

In conclusion, it is very seldom, even at the present day, that a species is described with the fulness, precision and detailed accuracy noticed in Bruguière's description of *Buccinum tessellatum*, and generally in all descriptions by that author. If all specific distinctions depended on descriptions of similar merit, the troublesome uncertainties of identification, of which the present imbroglio is but too common an instance and which so seriously impede zoological research, would *never* happen. There cannot possibly be two interpretations of Bruguière's description above analysed, and it would be inexcusable to substitute any subsequently published appellation in place of his *Buccinum tessellatum*.

While adhering, in the text of his descriptions, to the limits of the genus *Buccinum* as expanded by Linnæus, Bruguière nevertheless classifies the species into two sections, of which the first one is explicitly stated to coincide with d'Argenville's genus *Dolium*. This must be the reason why Bruguière has not adopted the Linnean specific name "*dolium*," to avoid a repetition in the event of a reinstatement of d'Argenville's genus *Dolium*, the use of which was indeed resumed on the plates illustrating Bruguière's descriptions.¹

The next in date amongst the important works concerning the question under consideration is Lamarck's "*Histoire naturelle des animaux sans vertèbres*." The general standard of Lamarck's method compares unfavourably with that of Bruguière, though it is but fair to keep in mind the adverse circumstances that have affected the work of all naturalists during his time and ever since; for he was not so happily situated as Bruguière who had the good fortune to terminate much of his work on the very eve of that terrible catastrophe which has for ever retarded the rate of progress of scientific knowledge and of all intellectual culture. Lamarck deserves our admiration all the more for his undaunted perseverance amidst circum-

¹ At least so I gather from the references to Bruguière's figures as given in the synonymy by Lamarck, Deshayes, and Küster. As already mentioned the plates of the *Encyclopédie* are not available in Calcutta.

stances unfavourable or even hostile to scientific research. Lamarck has followed Bruguière in reinstating d'Argenville's genus *Dolium*. It may be noticed that, in the generic diagnosis, Lamarck has introduced a clause "labro per totam longitudinem dentato vel crenato," so that, if it were desired to adhere strictly to Lamarck's definition, the name *Dolium*, *s. str.* would be applicable to the shells which it is proposed to classify as *Eudolium*, rather than to those classified with *Dolium galea*. As however *Dolium galea* is the species first mentioned, it has been decided that it is the type of the genus, and although it would be geologically and historically more logical to reserve the name *Dolium*, *s. str.* for the forms with denticulate labrum, yet there is no distinct advantage to be gained in altering an established usage.

In defining his *Dolium maculatum*, Lamarck has transcribed the synonymy of Bruguière's *Buccinum tessellatum*, similarly differing from Linnæus' and Gmelin's synonymy of *Buccinum dolium* in admitting the appositeness of only two of the figures from Martini's work. But for this correction, copied from Bruguière, the synonymy of Lamarck's *Dolium maculatum* is as hopeless a medley as that of Linnæus' *Buccinum dolium* or of Bruguière's *Buccinum tessellatum*. From the synonymy, there is no reason why Lamarck's *Dolium maculatum* should represent a different species from Bruguière's *Buccinum tessellatum* or *Dolium tessellatum* also mentioned in the synonymy; no reason being given for superseding the name established by Bruguière. The specific name used by Linnæus is set aside by Lamarck presumably for the same reason as by Bruguière, that is on account of the re-establishment of the generic name *Dolium*, to avoid a repetition. The description given by Lamarck runs as follows: "testa ovatoglobosa, ventricoso-inflata, tenui, alba; costis convexis, distantibus, fulvo aut rufo maculatis; interstitiis stria prominula divisus." The last clause may indicate that it is especially the shell above described as *Dolium maculatum*, Deshayes which Lamarck had in view, though, without any account of the development of the shell, it is insufficient to clear up the uncertainties of the synonymy. In conclusion, *Dolium maculatum*, Lamarck is just as uncertain as *Buccinum dolium*, Linnæus.

The next important publication dealing with this subject is probably posterior to the one of Lamarck above analysed, being the genus *Dolium* in Sowerby's "*Genera*," which presumably appeared in 1823. It contains an admirable figure of a shell which Sowerby has called *Dolium fimbriatum*, and which tallies in every respect with Bruguière's description. For those who, following the example of Küster, reject the specific names *minjac* and *tessellatum*, it is evident that the shell in question must be known as *Dolium fimbriatum*, Sowerby.

In 1830, seven or eight years later therefore than the publications of Lamarck and of Sowerby, Menke, in the second edition of the catalogue of his private collection, mentioned, as a new species, a *Dolium costatum*, with no other reference than Martini's figure 1082, therefore, one of the two figures specially selected by Bruguière as representing his *Buccinum tessellatum*, and by Lamarck as representing his *Dolium maculatum*. The date 1828 given by Tryon for this species is apparently incorrect,

for, according to Küster, the species was established not in the first edition of Menke's catalogue (published in 1828 and not available in India), but only in the second. The adoption of the same name for a similar shell by Deshayes in 1845 is a coincidence, as Deshayes was not acquainted with Menke's catalogue. Küster's remark to the effect that "for a long time previous to Deshayes, Menke had recognised this species, fortunately under the same name, and had entered it as such in the second edition of his Synopsis together with a diagnosis in the appendix," is partly incorrect, for Menke never seems to have described his *Dolium costatum*: the diagnosis in the appendix referring not to *Dolium costatum*, but to a *Dolium tenue*, from the coasts of Syria, rightly considered by Tryon to be an immature specimen of *Dolium galea*.

The first definite information subsequent to Bruguière's description and Sowerby's figure, that we can gather regarding the shells under consideration, is that contained in the Xth Volume, published in 1845, of Deshayes' new edition of Lamarck's "*Animaux sans Vertebres*." A truly reliable character is at last noticed by means of which *Dolium maculatum* can be identified, namely the inferior number of its primary ribs as compared with *Dolium tessellatum*, Bruguière, for which Deshayes adopts the specific name *minjac*, Adanson. It is only, therefore, from the date of Deshayes' work that *Dolium maculatum* can truly be recognised as a distinct species. As already mentioned, *Dolium costatum* is described by Deshayes as distinct from his *Dolium minjac*, the agreement in name with Menke, resulting, as above noticed, from a coincidence.

Reeve, in 1849, in his monograph adorned with the superb illustrations of Sowerby, has adopted the three species established by Deshayes, for one of which he adopts the specific name *fimbriatum*, Sowerby, *tessellatum*, Bruguière being rejected on the unfounded plea that it refers both to *D. fimbriatum* and to *D. maculatum*, while the specific name *minjac* mentioned in the synonymy is rejected on account of its non-latinity. The short explanatory notices contain some inaccuracies, as in the statement, reproduced from Deshayes, that *Dolium fimbriatum* is characterised "by the outer lip becoming strongly fimbriated on arriving at maturity," just the opposite of what really takes place as had already been observed by Bruguière. In the beautifully illustrated monograph published in 1857 as part of the Revision of Martini and Chemnitz' Conchilien-Cabinet, Küster has unreservedly accepted Reeve's conclusion, also including a fourth species, *Dolium ampullaceum*, Philippi, and adding a fifth, *Dolium lischkeanum*. The figure and diagnosis of *Dolium ampullaceum* are merely reproduced from Philippi's work, the shell, of which only a dorsal view is given, evidently representing a large specimen of *D. tessellatum*, Bruguière. *Dolium lischkeanum* is founded on adult specimens of the same species, in which the apertural thickening is therefore reduced, according to the adult characteristics already so clearly defined by Bruguière. The name established by Bruguière is rejected for the same unfounded reason as by Reeve, its supposed applicability to two different species. The reason alleged for rejecting the specific name *minjac* is not without some just foundation: "Without necessarily ignoring all the rules of nomenclature,

the names capriciously bestowed by Adanson, cannot nevertheless lay claim to the right of priority such as desired by Mr. Deshayes."

Finally, in Tryon's great work, the Manual of Conchology, the interpretation adopted in the case under consideration is arbitrary in the extreme: *D. maculatum*, Lamarck, *D. fimbriatum*, Sowerby, and *D. costatum*, Menke are regarded as mere varieties (or even less than varieties) of a single species for which the much older specific names *minjac*, Adanson, *dolium*, Linnæus, and *tessellatum*, Bruguière are rejected under the pretext that some uncertainty remains as to the particular variety to which they might have been originally applied. If the various forms really did represent mere varieties, it is obvious that the oldest name published would be that of the species, and that the varieties would be named according to the precedence in date recognised for each precise identification. Furthermore, not only does Tryon reject these names on a pretext which, from his point of view, cannot be considered valid, but, of the three other names that are allowed to stand, it is not the oldest, Lamarck's *maculatum* which is adopted as the name of the species, but Menke's *costatum* which is certainly newer by several years than either of the two others.

The foregoing lengthy discussion was unavoidable in order to arrive at some definite conclusion regarding the names to be adopted for the two species recognised in the present work. It should now appear sufficiently evident that the two names to be adopted are *Dolium tessellatum*, Bruguière 1789, and *Dolium maculatum*, Deshayes 1845.

For those who prefer archæological erudition, however inconvenient, to the more familiar nomenclature of long-established usage and tradition, there seems to be no doubt that either *Dolium minjac* (Adanson) 1757, or *Dolium dolium* (L.) [Huddesford] 1770, is the name that should be adopted for the shell above described as *Dolium maculatum*, Deshayes. The adoption of such a course must carry with it the usual warning that the pseudo-scientific security attained by the archæological method has too often proved a delusion, for there is always the risk of an industrious bibliographer discovering some forgotten monograph of earlier date than the one relied upon as final. In any case, even as regards the substitution of *Dolium dolium* to *Dolium maculatum*, this would be somewhat of a retrospective interpretation, for no one who had not made an exhaustive study of the shells under consideration could recognise which species is meant by Lister's illustration. Neither the figure nor the description of Lister nor the identification of Huddesford are of any real help in identifying the species, and it is necessary to come down to the period of Deshayes to obtain at last a sure method of recognising it.

If the Lamarckian appellation *Dolium maculatum* be definitely adopted for one of these species, it may perhaps be objected that to follow this specific name with "Deshayes" as the author, as has been done in the present work, is not in accordance with the recognised rules of nomenclature. The prevailing custom of appending to the name of a species, whenever mentioned, the name of the earliest author who has made use of such a specific name is in many cases of little scientific value. The object of this apposition is to avoid confusion, the mention of the author's name pur-

porting to be an abbreviated reference to the earliest work in which a particular specific name has received a definite meaning. If, however, the author quoted is one who has only given an ambiguous definition, the abbreviated reference fulfils no useful purpose. To be historically and scientifically useful, the reference should be to the earliest author who has bestowed a definite meaning upon the name, whether or not it may previously have been used in an unsatisfactory manner. For instance, "*Dolium maculatum*, Lamarck" does not convey any useful information since it is not possible, from Lamarck's description, to ascertain which shell he had in view, while "*Dolium maculatum*, Deshayes" immediately gives the required clue since we need only refer to Deshayes's work to know precisely which form is meant.

Characteristic differences between the two species.—From the foregoing description, it is clear that the forms under consideration are both very well defined and remarkably constant, and it is easy therefore to detect the particular features that differentiate them from one another. Amongst the more striking differences, the following may be particularly mentioned.

Firstly. The protoconch in *Dolium tessellatum* is smaller, more prominent, less oblique, darker-coloured than in *Dolium maculatum*. The secondary infilling of porcellaneous shell-substance which occupies the whole interior of the protoconch in the case of *Dolium maculatum* does not reach the apex in the case of *Dolium tessellatum*.

Secondly. The number of primary ribs visible on the spire-whorls is three or four in the case of *Dolium tessellatum*, two or three in the case of *Dolium maculatum*. The intervening spaces in the case of *Dolium maculatum* carry intercalary threads of three orders, of which only those of the highest order are apt to disappear with increasing growth. In the case of *Dolium tessellatum* the intervals, in the portion immediately following the protoconch, carry intercalary threads of two orders only, all of which vanish entirely or almost entirely with increasing growth.

Thirdly. The number of primary ribs on the body-whorl of *Dolium maculatum* is ten or eleven, and remains perfectly constant at all stages of growth. In the case of *Dolium tessellatum* the body-whorl of very small specimens carries twelve primary ribs, the number increasing, by anterior additions, to as many as sixteen in the case of very large specimens.

Fourthly. The intercalary decoration in the case of specimens of average size of *Dolium maculatum* includes, in the broader intervals, threads of two orders, much narrower than the primary threads. In the case of very large specimens some of these intercalary threads may broaden into bands resembling the primary ribs, while threads of a higher order may also appear. In the vast majority of specimens of *Dolium tessellatum* there is practically no intercalary spiral sculpture on the body-whorl. In the case of very large specimens there may appear some intercalary bands, the number of which, in a single primary interval, never exceeds two. These intercalary ribs of full-grown specimens of *Dolium tessellatum* are apt to assume the maculated colour decoration of the primary ribs, while this is very rarely observed in the case of *Dolium maculatum*.

Fifthly. The columella of *Dolium tessellatum* is shorter than that of *Dolium maculatum*. Except in the case of very large, quite adult specimens, it is always rugose in the case of *Dolium tessellatum*, while it is smooth at all stages of growth in the case of *Dolium maculatum*.

Sixthly. The vast majority of specimens of *Dolium maculatum* of all sizes have a perfectly simple outer lip. When the outer lip is at all differentiated, it is feebly expanded externally, feebly thickened and non-denticulate internally, with a more or less wavy, feebly fimbriated edge. In the case of *Dolium tessellatum* the outer lip is invariably differentiated, its special characteristics, in the case of the largest fully adult specimens, being reduced to a mere internal thickening, while in every specimen of small or medium size it is externally expanded, internally thickened and denticulate, and is conspicuously fimbriated all along the edge.

In conclusion, the differences are amply sufficient to justify the reference of both forms to totally distinct species which are not even closely related. The simplification of the aperture in fully adult specimens of *Dolium tessellatum*, combined with the adult reappearance of an intercalary sculpture, taken in connection with the adult broadening of the intercalary ribs usually observed in *Dolium maculatum*, gives rise to a deceptive suggestion of convergence which, nevertheless, is quite superficial. The history of the development of both shells clearly shows how widely divergent are their zoological affinities.

Affinities of the two species.—*Dolium maculatum* appears to be an isolated species amongst the recent fauna, and is not closely related to any other known living form. In the characters of the outer lip, of the columella and of the umbilicus it distinctly recalls *Dolium galea*, the type of the genus, as well as the closely related *Dolium melanostoma*, Jay and *D. variegatum*, Lam., but is clearly separated by the wide-spaced disposition of the primary ribs which, on the contrary, are close-set in *Dolium galea* and the related forms. In any case *Dolium maculatum* is to be classified as a typical *Dolium*.

Dolium tessellatum, if we leave out of account the fully adult or gerontic individuals, is undoubtedly closely related to *Dolium fasciatum*, Brug., with which it agrees as regards the posteriorly channelled aperture, the rugose columella, the externally and internally thickened, denticulate and fimbriate outer lip, being distinguished only by the somewhat less ovoid outline of the body-whorl, and the smaller number and wider spacing of the primary ribs, as well as some differences in the colour decoration. It also shows a relationship though more distant to *Dolium zonatum*, Green. In their apertural characters, *Dolium fasciatum* and *D. zonatum* correspond so closely with *Dolium crosseanum*, Mont., the type of *Eudolium*, as to justify their inclusion within that subgenus or section; the exact classificatory position of *Dolium tessellatum* being rendered thereby, as already mentioned, somewhat uncertain, since it may be regarded as a *Eudolium* when immature, a *Dolium*, *s. str.* when full grown. It is clearly at the mutual limit of the two groups, and indicates how feebly defined is their separation.

The pliocene beds of the Mekran contain an extinct species which has provision-

ally been named *Dolium ormarensse*, and which, as shown by the characters of its aperture, undoubtedly belongs to the same group as *Dolium tessellatum*. The size, number, and spacing of the primary ribs on the body-whorl is in complete agreement with the recent form from which the fossil differs owing to the presence of a well-developed intercalary rib of the second order in each interval at all stages of growth; the broader posterior primary intervals also showing indications of threads of a third order. The spire is more sunken than in the recent form and recalls that of *Dolium maculatum*.

In his first monograph on the tertiary fossils of Java (*Tertiärschichten auf Java*, p. 40, 1879) Martin has mentioned the occasional presence of intercalary ribs on the body-whorl of "*Dolium costatum*," that is therefore of *D. tessellatum*. On the strength of this observation, Boettger (*Die Tertiaerformation von Sumatra und ihre Thierreste*, 2nd part, p. 84, pl. vi, figs. 4, 5; *Palaeontographica*, Supplementary Vol. III) has referred to *Dolium costatum* as a variety *martini*, a tertiary fossil from Sumatra in which intercalary ribs are conspicuously developed at all stages of growth. Nevertheless, since Martin specially mentioned that the occasional development of intercalary ribs takes place on the body-whorl, the remark doubtless applies to the adult character of full-grown specimens; especially as, in his latest work on the subject (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, 1899, p. 161), Martin has specially described the complete or almost complete disappearance of the interstitial decoration, with increasing growth, on the spire-whorls. In this latest work, Martin has accepted Boettger's identification without discussion, by simply recording it in the synonymy. Yet the intercalary ribs, in the specimens figured by Boettger, are far more prominent than is known ever to be the case in specimens of *Dolium tessellatum* of corresponding size. There is every reason to believe that the fossil *Dolium martini* is identical with the form provisionally named *Dolium ormarensse*, especially as the spire seems to agree exactly with that of the Mekran fossil and not with the true *Dolium tessellatum*.

Another doubtful form is *Dolium modjokasriense*, Martin, fossil from the later tertiary of Java (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 160, pl. xxv, fig. 370), in which the spire is disposed exactly in the same manner as in *Dolium maculatum*, with exactly the same spiral decoration consisting of conspicuous ribs or threads of three orders, with indications of a fourth, this decoration being similarly continued on the corresponding posterior portion of the body-whorl. Anteriorly to the level of the suture, the body-whorl is said to differ from that of *Dolium maculatum* owing to the presence of only two alternating orders of spiral ornaments instead of three; only, this part of the solitary available specimen is so poorly preserved as to permit of a doubt as to whether the ribs interpreted as representing the first order may not partly correspond with the expanded ribs of the second order as frequently observed on adult specimens of *Dolium maculatum*, in which case the fossil under consideration would be a specimen of *D. maculatum* such as is already known in a fossil condition from the upper tertiary of the Mekran. Otherwise, if the interpretation accepted in the original description be correct, the

diagnosis merges into that of *Dolium ormareense*. Nevertheless the prominence of the spiral ornaments of the second and third order on the spire-whorls recalls *Dolium maculatum* more than *D. ormareense*. This question cannot perhaps be definitely settled without the discovery of better preserved specimens, especially such as might exhibit the apertural characters.

Another fossil species from the pliocene of Java, *Dolium hochstetteri*, Martin (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 162) is perhaps also to be classified in the same group with *Dolium tessellatum*, from which it is distinguished by its extremely flattened spire and the posterior inflation of the body-whorl. The details of the aperture are unfortunately not known.

Lastly, another upper tertiary fossil from the Mekran, provisionally named *Dolium arabicum*, and probably identical with *Dolium townsendi*, Newton (*Geol. Mag.*, dec. 5, Vol. II, p. 301) is probably also related to *Dolium costatum*, with which it agrees in the shape and ornamentation of the spire, but from which it differs owing to the irregular distribution of the spiral ribs on the body-whorl. In this case also, owing to the absence of the apertural characters, the precise affinities of the species remain uncertain.

Distribution of Dolium tessellatum and Dolium maculatum.—The areas over which the two species are found at the present day are to a large extent distinct, though they partly overlap. *Dolium tessellatum* does not seem to spread further west than the eastern portion of the Bay of Bengal, nor *Dolium maculatum* further east than the Malay Islands, while, in a westward direction, *D. maculatum* occurs apparently throughout the Arabian Sea, and, in an eastern direction, *D. tessellatum* extends as far as Japan. The geographical range of *D. tessellatum* appears to have been more extensive in former geological times than at the present day, for its occurrence as a fossil in the Mekran beds indicates its former presence, in later tertiary times, in the area now occupied by the Arabian Sea.

III.—THE SPECIFIC IDENTITY OF *DOLIUM LUTEOSTOMA*, KÜSTER, WITH *DOLIUM VARIEGATUM*, LAMARCK, AND OF *DOLIUM MAGNIFICUM*, G. B. SOWERBY, WITH *DOLIUM CHINENSE*, DILLWYN.

I.

On a previous occasion (*Journal As. Soc. Bengal*, new series, Vol. XIV, 1918, p. 449) I have commented upon the apparently discontinuous distribution of *Dolium variegatum*, Lamarck, a conspicuous shell previously regarded as special to the Australian region, but which has now been shown to occur also in the northern part of the Arabian Sea. The collections in the Indian Museum include specimens from Maskat, and I have also ascertained the presence of the shell at Karachi. It was moreover noticed that a shell found at Charbar on the northern shore of the Gulf of Oman, by Mr. Townsend, and referred by Melvill and Standen to "*Dolium galea* var. *luteostomum*" (*Proc. Zool. Soc. London*, 1901, Vol. II, p. 385), probably also represents a specimen of *Dolium variegatum*.

The specimens of *Dolium variegatum* from the collections of the Indian Museum hitherto studied were all of relatively moderate dimensions. Since the note above alluded to was written, several more specimens have come to notice, unfortunately of uncertain origin, remarkable for their large dimensions, and clearly corresponding with the figured types of *Dolium luteostoma* and of the synonymous *Dolium japonicum*, Dunker. At the same time, their specific identity with *Dolium variegatum* does not admit of any doubt, and hereby is explained the occurrence of *Dolium luteostoma* in the Arabian Sea as recorded by Melvill and Standen. It now remains to be seen whether *Dolium variegatum* itself is to be treated as specifically identical with *Dolium galea*, since the synonymous *Dolium luteostoma* is regarded by Melvill and Standen as a mere variety of that species.

With the exception of Küster, in his monograph of the genus *Dolium* published in 1857 as part of the revised edition of Martini and Chemnitz' "Conchilien-Cabinet," the authors who have dealt with these particular shells have only given short diagnoses insufficient for identifying the various species. Even in the case of Küster's work, the excellent descriptions are mostly unaccompanied by comparative criteria. It is therefore necessary to rely principally upon illustrations and upon actual specimens for the discrimination of the species. With regard to the possible specific distinctness of the forms variously described as *D. galea*, *D. variegatum*, and *D. luteostoma*, the question is still further complicated by the necessity to take into account a *Dolium melanostoma*, Jay (1839, Cat. Mus., p. 124, pl. viii-ix), with which *D. luteostoma* is regarded by Tryon (Manual of Conchology, Vol. VII, p. 261) as possibly identical.

Apart from Melvill and Standen, in the above quoted reference, none of the authors who have dealt with *Dolium luteostoma* appear to have had any hesitation in considering it to differ specifically from *Dolium galea*, from which it is distinguished, at the first glance, by its fewer and wider ribs. Tryon is the only author who has thought it worth while to compare *Dolium variegatum* with *Dolium galea* and with *Dolium luteostoma* and records, as the only distinction from the two species last named, a relatively shallower sutural groove or rather depression, and a more elevated spire for *D. variegatum*.

It need scarcely be mentioned that differences of this kind, depending on mere matters of degree and totally ignoring individual variation, are worthless from the point of view of precise specific discrimination. I have vainly endeavoured, with the material now available, to discover other distinguishing features. The degree of elevation of the spire is extremely variable from one specimen to another, as is obvious from the two specimens of *Dolium variegatum* figured in Reeve's monograph. Of the two specimens of *Dolium variegatum* as interpreted by Küster, illustrated in plate lxiii of his monograph, the larger one has so short a spire that it has unhesitatingly been referred to *Dolium luteostoma* by Tryon; (the figure of the smaller specimen being copied from Reeve). Moreover, the degree of elevation of the spire may vary widely at different stages of growth even in the same specimen; as in the case of the larger of the two specimens figured by Reeve, and also in the case of a very fine specimen in the collections of the Indian Museum, measuring 168 × 139 mm.,

in which the suture becomes increasingly oblique with increasing growth, so that, at earlier stages, the spire is extremely depressed, and gradually becomes more elevated in the full-grown shell. In the case of such specimens, the earlier whorls exactly agree with the diagnosis of *Dolium luteostoma*, the later ones with that of *Dolium variegatum*. As to the sunken disposition of the suture in various individuals or in various portions of one specimen, it is more or less pronounced inversely to the degree of obliquity, but is always distinct.

We may conclude that *Dolium variegatum*, Lamarck, and *Dolium luteostoma*, Küster, undoubtedly represent the same species, which should be known by Lamarck's designation which is older.

The shell is undoubtedly very closely related to *Dolium galea*, Linn., though it cannot be referred to the same species as has been done by Melvill and Standen who, as already mentioned, have catalogued it from the Gulf of Oman as "*Dolium galea* var. *luteostomum*." The spiral ribs, even taking full account of individual variations, are always fewer in *Dolium variegatum* than in *Dolium galea*. At the largest stages of growth, the number of main ribs, in *Dolium variegatum*, never exceeds nineteen, and is usually less (frequently fifteen), while *Dolium galea* has at least twenty ribs even in the case of small specimens, and usually more. There is also a very distinct difference in the general shape of both species at all stages of growth, the convexity of the body-whorl being more evenly continuous in *Dolium variegatum* than in *Dolium galea*, in which latter species there is a decrease in the degree of curvature along the zone of maximum width, communicating a slightly flattened appearance to the sides of the shell.

There remains to be considered the case of *Dolium melanostoma*, Jay, a remarkably handsome shell, the name of which refers to the dark colour pervading the aperture, principally over the columellar lip. It seems to occur abundantly throughout Polynesia and as far north as the Hawaiian Islands, but is not represented in the collections of the Indian Museum. The two illustrations hitherto published, in the works respectively of Jay (*loc. cit.*) and of Reeve (Monograph of the Genus *Dolium*, species 2) are in every respect consistent with one another except as regards the number of principal spiral ribs on the body-whorl, which amounts to twenty on the specimen figured by Reeve, but which does not exceed fifteen in Jay's original type. The number of ribs varies therefore approximately within the same limits as in the case of *Dolium variegatum*, of which, judging by this character alone, *Dolium melanostoma* might be merely a colour-variety. But there are other differences besides those of colour. Judging from the apparently excellent illustrations, the outline of the spire is more subulate, with less convex whorls than in *Dolium variegatum*. The sutures are decidedly less sunken than in either *Dolium galea* or *Dolium variegatum*. The absence of spiral ribs on the anterior winding terminal bulge of *Dolium melanostoma* already noticed by Reeve as a good distinction from *Dolium galea* similarly distinguishes it from *Dolium variegatum*. The spire, in Jay's original type, is taller than would seem ever to be the case with *Dolium variegatum*, while, in the specimen figured by Reeve, it also exceeds the average of *Dolium variegatum*; it is therefore probably

more elongate, on an average, in *Dolium melanostoma* than in *Dolium variegatum*, though further information is necessary to make certain about this point. The narrow intercalary ribs appear to alternate with the larger ones much more regularly in *Dolium melanostoma* than in either *Dolium galea* or *Dolium variegatum*. In this respect, as also with regard to the feebly sunken sutures, *Dolium melanostoma* recalls *Dolium chinense*, Dillwyn, but its ribs do not become so completely flattened out as in the last-named species. Lastly, *Dolium melanostoma*, like *Dolium galea*, lacks the brown maculations of *Dolium variegatum* and *Dolium chinense*.

We may conclude that *Dolium melanostoma* is specifically distinct both from *Dolium galea* and from *Dolium variegatum*. There exists therefore, at the present day, a group of three closely related species, each with its special geographical distribution: *Dolium galea* inhabiting the Mediterranean and Atlantic, *Dolium variegatum* characterising the Indian Ocean and western shores of the Pacific, and *Dolium melanostoma* in the central Pacific region. As pointed out on a previous occasion, it is improbable that so conspicuous a species as *Dolium variegatum* should have been overlooked in the Bay of Bengal and Malay region if it really lived in those portions of the ocean; and its occurrence in the northern part of the Arabian Sea suggests therefore a discontinuous distribution for that species. It is known to exist along the northern and eastern coasts of Australia, but we cannot at present ascertain whether it spreads continuously across the intervening seas from Australia to Japan, in which latter region it is also known to occur, this being the *habitat* of *Dolium japonicum*, Dunker, synonymous with *Dolium luteostoma* and with *Dolium variegatum*. We know that *Dolium variegatum* has been in existence since miocene times, and from the distribution of the fossil occurrences, we may conclude that its present discontinuous distribution is due to the local shrinking of a once connected area. No fossil occurrences of *Dolium galea* or *Dolium melanostoma* have been discovered, but our knowledge of the later tertiary marine faunas of tropical regions is as yet too incomplete to lay stress upon this circumstance.

II.

The second point to be discussed is the relationship to *Dolium chinense*, Dillwyn, of a form described in 1904 by G. B. Sowerby as a new species under the name of *Dolium magnificum* (Proc. Malac. Soc. London, Vol. VI, p. 7, fig. 1). The specimen described and figured by Sowerby was obtained by the late General Tripe from China, from the very home, therefore, of *Dolium chinense*.

We have evidently to deal, here, with another of the numerous instances in which, in the genus *Dolium*, large individuals are apt to differ considerably in appearance from smaller specimens of the same species; though in the present case the difference is not of an extremely marked degree. The specimen of *Dolium chinense* figured in Reeve's monograph measures 75 mm. in height. A specimen of nearly the same size, closely corresponding with the one figured by Reeve, is to be found in the collections of the Indian Museum, together with some smaller ones and a much larger one which will be further alluded to. The maximum height of *Dolium chinense*, according to Küster, is $3\frac{1}{3}$ ", therefore more than 80 mm. The type-specimen of *Dolium magnificum* has a

height of 110 mm., not disproportionately greater therefore than the largest previously known specimens of *Dolium chinense*. In addition to its large size, it is considered to be further differentiated by the character of its spiral threads, said to be flatter than in *Dolium chinense*. At all stages of growth, *Dolium chinense* is always characterised by its relatively flat ribs, this feature constituting a good distinction from *Dolium variegatum*, with which it has been erroneously united by Philippi and by Tryon. The collection of the Indian Museum includes a specimen, unfortunately of unknown origin, measuring 115×98 mm., even larger therefore than G. B. Sowerby's type of *Dolium magnificum*, with which it otherwise corresponds in every respect. The ribs of the body-whorl, as in the case of Sowerby's type, are still flatter than in specimens of *Dolium chinense* of moderate size; the ornamentation, indeed, consisting of linear grooves rather than ribs. Yet, the spire-whorls plainly show that, at earlier stages of growth, the ribs are less flattened and are disposed exactly as in typical specimens of *Dolium chinense*. The protoconch of the specimen corresponding with *Dolium magnificum* is of exactly the same size and shape as in typical specimens of *Dolium chinense*; indeed, all the earlier portion of the spire is absolutely undistinguishable. The paired disposition of the maculated ribs observed in the type of *Dolium magnificum*, and in the corresponding Calcutta specimen, is frequently matched amongst typical specimens of *Dolium chinense*. It seems obvious that *Dolium magnificum* is specifically identical with *Dolium chinense*, of which it represents a full-grown stage.

Even these exceptionally large specimens of *Dolium chinense* do not nearly approach the maximum dimensions of *Dolium variegatum*, which reaches as much as 230 mm., and ranks amongst the largest known gastropods. *Dolium chinense* is therefore well distinguished from *Dolium variegatum* by its smaller average size, its feebly sunken sutures, and its more crowded and flatter ribs, the difference becoming especially marked in large specimens of both species, since, in the case of *Dolium variegatum*, there is no indication, with increase of size, of the extreme flattening characterising the full-grown stage of *Dolium chinense*.

IV.—LIST OF THE DOLIIDÆ IN THE COLLECTION OF THE INDIAN MUSEUM.

While engaged upon the study of the tertiary fossil Doliidæ in the collections of the Geological Survey of India, I had occasion to examine, for purposes of comparison, the rich series of recent shells of this family in the zoological collections of the Indian Museum. Many of these valuable specimens had remained unnamed, and, as the work of comparison necessitated the identification of the recent as well as of the fossil specimens, advantage may be taken of the present opportunity to place on record the contents of the collection of recent shells, all the more so as, in the majority of cases, we possess precise details as to the locality from which the specimens were obtained; the information thus obtainable supplementing in several instances that previously published.

According to the classification schemes of Fischer (*Manuel de Conchyliologie*,

p. 661) and of Cossmann (*Essais de Paléoconchologie comparée*, fasc. V, p. 136), the Doliidæ include two genera, *Dolium* and *Pirula*, while *Dolium* is itself divided into three subgenera, namely *Dolium*, *s. str.*, *Eudolium* and *Malea*. Several authors treat *Malea* as a separate genus.

Genus **Dolium**, d'Argenville, 1757.

The species of *Dolium*, both fossil and recent, hitherto recorded are provisionally grouped in the following list in which are included also two fossil species from the Mekran district, of which the descriptions are not yet published, and which are mentioned with provisional names, but which probably correspond with two species which have already been named and figured. This particular question will be fully discussed, it is hoped, at no very distant date in the publications of the Geological Survey of India.

The proposed limits of the subgenus *Eudolium* have been discussed in a foregoing paper.

The species included within the three subgenera of *Dolium* may be grouped in the following nine divisions:

Dolium, *s. str.*

It is proposed to restrict *Dolium*, *s. str.* to those shells in which the outer lip is simple or internally slightly thickened, and the columella smooth at all stages of growth.

1st Division.

This division which may be called the group of *Dolium galea* (Linn.), after the type of the genus, includes globose or slightly ovoid shells of large or very large size in which the spiral ribs are mostly contiguous or nearly so. The following forms have been recognized:—

Dolium galea (Linn.), in which the ribs are very numerous and the sutures deeply sunken. There is a marked decrease in the degree of curvature along the zone of maximum width, this portion of the shell tending therefore to assume a sub-cylindrical outline.

Dolium variegatum, Lamarck, in which the ribs are fewer and the curvature more continuous than in *Dolium galea*, from which it is usually distinguished also by the presence of brown maculations along many of the ribs. Küster's *Dolium luteostoma* and Dunker's *D. japonicum* are synonymous.

Dolium melanostoma, Jay, in which the number of ribs and the shape of the body-whorl are about the same as in *D. variegatum* from which it is distinguished by its more subulate spire, the feebly sunken sutures, the absence of maculations on the ribs, and the dark tint of the aperture.

Dolium chinense, Dillwyn, distinguished from *D. variegatum* by its smaller size, more numerous and more flattened ribs, and its feebly sunken suture. *Dolium magnificum*, G. B. Sowerby, represents the full-grown condition of this species.

Dolium olearium, Bruguière, which resembles *Dolium variegatum* in general out-

line; sutures sunken; ribs about as numerous as in *D. variegatum*, only much flatter and separated by mere linear shallow grooves, without intercalary ribs.

Dolium perdix, Linnaeus, larger and more ovoid than *Dolium chinense*; sutures not appreciably sunken; ribs quite flat and about as numerous as the primary ribs of *Dolium chinense*, separated by linear grooves without the intercalary ribs that characterise *Dolium chinense*. Nevertheless, the resemblance to *Dolium chinense* becomes very close in the case of immature specimens of *Dolium variegatum*, which are apt to be relatively much more globose than the adult. The resemblance is accentuated by the fact that the intercalary ribbing is absent in the case of immature specimens of *Dolium chinense*. Nevertheless, the immature specimens of *Dolium chinense* are distinguished by the conformation of the terminal zone of accretions which, when viewed dorsally, appears somewhat more bulging and convex, and is separated from the convexity of the base by a slightly better defined concavity than in the case of the immature specimens of *Dolium perdix*. The protoconch of *Dolium perdix* is considerably larger than that of *D. chinense*.

Tryon regards *Dolium cumingii*, Hanley, *D. deshayesi*, Reeve and *D. testardi*, Monterosato, as varieties of *D. olearium*; a most unlikely interpretation, for, judging from the excellent published illustrations, the absence of a circumsutural channel, the shape and ornamentation of the spire, the sculpture and decoration of the body-whorl, suggest a close relationship, if not specific identity, with *Dolium perdix*.

2nd Division.

Large globose shells with the ribs separated by wide intervals.

Only one species can with certainty be ascribed to this division: this is *Dolium maculatum*, Lamarck. The Java fossil *Dolium modjokasriense*, Martin, as already explained (p. 172), is perhaps identical.

3rd Division.

This division only includes the fossil *Dolium losariense*, Martin (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 163, pl. xxv, figs. 377, 378), distinguished from all other species by the marked posterior angulation of the body-whorl. So far as can be made out its outer lip is simple.

Subgenus **Eudolium**, Dall, 1889.

(= *Doliopsis*, Monterosato, 1872, *non* Conrad).

According to the interpretation here proposed, the subgenus *Eudolium* includes those forms in which, throughout the greater part or the whole of the life of the shell, the aperture is somewhat channelled posteriorly, the columella rugose, and the outer lip internally denticulate.

4th Division.

The shells of this division, which may be distinguished as the group of *Dolium tessellatum*, include umbilicated shells in which the primary ribs are wide-spaced. In *Dolium tessellatum* itself, the only form of this group in which the development of

the shell is entirely known, the apertural denticulations and the collumellar rugosities disappear in the case of thoroughly adult individuals, the species establishing therefore somewhat of a link between *Dolium*, s. str. and *Eudolium*.

In those forms of which the apertural details are known the denticulations are bifid. The forms which may be either definitely or provisionally classified in this group are the following :—

Dolium tessellatum, Bruguière, in which conspicuous intercalary ribs appear only in fully adult shells.

Dolium ormarensense, Vred., fossil, in which conspicuous intercalary ribs are seen at every stage of growth ; *Dolium costatum* var. *martini*, Boettger (*Die Tertiäerformation von Sumatra und ihre Thierreste*, Part II, p. 84, pl. vi, figs. 4, 5, *Palaeontographica*, Suppl., Vol. III) being perhaps identical.

Dolium hochstetteri, Martin (*Samml. des geol. Reichs-Museums in Leiden*, new series, Vol. I, p. 162), characterised by its extremely depressed spire and posteriorly inflated body-whorl. The details of the aperture are not known, and the classification of this shell is therefore provisional.

Dolium arabicum, Vred., fossil, characterised by the irregular distribution of the ribs on the body-whorl ; *D. townsendi*, Newton (*Geol. Mag.*, dec. 5, Vol. II, p. 301), being probably identical. As in the case of the preceding species the details of the aperture are not known and the classification of the shell is likewise provisional.

5th Division.

In this division, which may be distinguished as the group of *Dolium fasciatum*, the shell is umbilicated, the ribs are crowded and close-set, the denticulations bifid. It includes the following species :—

Dolium fasciatum (Bruguière), in which the body-whorl is practically destitute of intercalary ribbing, and the outer lip thickened both internally and externally.

Dolium zonatum, Green, in which all the intervals carry intercalary threads and the labrum is thickened only internally.

6th Division.

The shells of this division, which may be distinguished as the group of *Dolium crosseanum*, differ from those of the preceding group merely in the absence of an umbilicus. The denticulations are similarly bifid. This group includes the following species :—

Dolium crosseanum, Monterosato, the genotype of *Doliopsis*, Monterosato and of *Eudolium*, Dall, characterised principally by its crowded spiral ornamentation closely resembling that of *Dolium zonatum*.

Dolium cinguliferum (Brown) (= *D. fasciatum*, Borson, non Bruguière), fossil, of smaller size, with fewer primary ribs.

Dolium muticum, Michelotti, fossil, strongly tuberculate, with labrum thickened externally as well as internally.

Dolium subfasciatum, Sacco, fossil, more delicately tuberculate than *D. muticum*, with the labrum similarly thickened externally.

Dolium stephaniophorum (Fontannes), fossil, delicately tuberculated like *D. subfasciatum*, but without the external thickening of the labrum.

Dolium antiquum, Sacco, also fossil, is only represented by a single incomplete cast, and its specific distinctness from *D. muticum* is doubtful.

7th Division.

This division only contains at present *Dolium verrillii*, Dall (*Bull. Mus. Comp. Zool.*, Vol. XVIII, 1889, p. 233, pl. xxxv, fig. 12), which is non-umbilicated, and which differs from all other forms of *Eudolium* owing to the callous thickening of its apertural margins, a character establishing a transition towards the subgenus *Malea*. The denticulations of the outer lip are coarse and apparently simple as is the case to a large extent in *Malea*.

Subgenus **Malea**, Valenciennes, 1833.

The subgenus or genus *Malea* includes shells in which the aperture is callous and exhibits coarse denticulations not only along the outer lip, but also along the columellar lip, both opposite the columella and opposite the base of the penultimate whorl.

8th Division.

In this division, which may be distinguished as the group of *Dolium pomum*, the degree of callosity of the aperture is moderate. It includes the following species:—

Dolium pomum (Linn.), ovoid, with feebly prominent, close-set, broad ribs and without intercalary ornaments.

Dolium orbiculatum, Brocchi, fossil, distinguished from the foregoing by the somewhat more crowded denticulations of the outer lip.

Dolium pro-orbiculatum, Sacco (= *D. denticulatum*, Deshayes *sec.* Hoernes), more globular than *D. orbiculatum*, with more even outline of the posterior part of the body-whorl, and with the spire generally taller and more subulate.

9th Division.

This division is characterised by the excessive degree of callosity of the aperture. It may be distinguished as the “group of *Dolium ringens*.” It includes the following species:—

Dolium ringens (Swainson), large, globose, with numerous fairly prominent ribs.

Dolium camurum, Guppy (*Quart. Journ. Geol. Soc.*, Vol. XXII, 1866, p. 287, pl. xvii, fig. 9), fossil, differing from *Malea ringens* in its smaller size, and in the flatter, less sharply defined spiral ribs separated by very narrow, but not deeply sunken intervals; the external decoration therefore somewhat recalling that of the shells belonging to the group of *Malea pomum*, and establishing a genealogical link between the two groups. In the shortness and prominence of the bunch of folds situated on the base of the penultimate whorl, and in the consequent great depth of the embayment separating it from the anterior columellar group, the shell entirely agrees with *Malea ringens*, of which it is clearly an ancestral pre-mutation.

It has not been possible to include in the above list *Dolium dunkeri*, Hanley (*Proc. Zool. Soc.*, 1859, p. 431), which does not appear to have been figured and cannot be identified from the short description, nor *Dolium procellarum* (*Bull. Soc. Malac. France*, 1885, Vol. II, p. 247), the description of which is not accessible in India.

The geographical and geological distribution of these various shells, so far as known, is the following:—

		Oligocene.	MIOCENE.		Pliocene.	Quaternary.	Recent.	
			Lower.	Upper.				
<i>Dolium galea</i> (Linn.)	..							Mediterranean and Atlantic.
„ <i>melanostoma</i> , Jay	..							Pacific.
„ <i>variegatum</i> , Lam.		Australia, Japan and Arabian Sea; fossil in the pliocene of Java, and of the Mekran.
„ <i>chinense</i> , Dillwyn		China; ? Malay Peninsula; fossil in the upper miocene of Java.
„ <i>olearium</i> , Bruguière	..							Indian Ocean, Philippines.
„ <i>perdix</i> (Linn.)	..							Indo-Pacific region and western Atlantic.
„ <i>maculatum</i> , Desh.	..							Arabian Sea to Moluccas, fossil in the pliocene of the Mekran (and of Java? = <i>D. modjokariense</i> , Martin?), and in the quaternary of the Pulicat lake near Madras.
„ <i>losariense</i> , Martin	..							Fossil in the pliocene of Java and of the Mekran.
<i>D. (Eudolium) tessellatum</i> , Brug.						...		Eastern Bay of Bengal to Japan; fossil in the upper miocene and pliocene of Java and in the pliocene of the Mekran.
„ <i>ormarensis</i> , Vred.								Fossil in the pliocene of the Mekran; <i>D. costatum</i> var. <i>martini</i> , Boettger from the upper tertiary of Sumatra is perhaps identical.

	Oligocene.	MIOCENE.		Pliocene.	Quaternary.	Recent.
		Lower.	Upper.			
<i>D. (Eudolium) Hochstetteri</i> , Mart.				—		Fossil in the pliocene of Java.
„ <i>arabicum</i> , Vred...				—		Fossil in the pliocene of the Mekran: <i>D. townsendi</i> , Newton is probably identical.
„ <i>fasciatum</i> (Brug.)					—	Western Bay of Bengal to Japan.
„ <i>zonatum</i> , Green ..				—	...	China and Japan; a fossil variety in the pliocene of Java.
„ <i>crosseanum</i> , Mont.					—	Mediterranean and West Indies.
„ <i>cinguliferum</i> (Bronn).		—	—	—		Fossil in the miocene and pliocene of the Piedmont.
„ <i>muticum</i> , Mich. ..	—					Fossil in the oligocene of Liguria; <i>D. antiquum</i> , Sacco is perhaps identical.
„ <i>subfasciatum</i> , Sacco		—				Lower (middle) miocene of the Piedmont.
„ <i>stephaniophorum</i> (Font.).			—	—		Fossil in the upper miocene of the Piedmont, and in the pliocene of the Piedmont and of the Rhone valley.
„ <i>verillii</i> , Dall. ..					—	West-Indies.
<i>D. (Malea) pomum</i> (Linn.) ..					—	“Red Sea to Society Islands.”
„ <i>orbiculatum</i> , Brocchi			—	—		Fossil in the upper miocene of the Piedmont, and in the pliocene of the Alpes-Maritimes, of Piedmont, and of Tuscany.
„ <i>pro-orbiculatum</i> , Sacco		—				Fossil in the Vienna region.
„ <i>ringens</i> , Swainson					—	Eastern Pacific.
„ <i>camurum</i> , Guppy		—				Fossil in Jamaica and San Domingo.

The presence of *Eudolium*, as here defined, in the oligocene of Europe, while, in the Eastern Seas, it is only known from upper miocene to recent times, and the occurrence of *Malea* exclusively as a fossil in Europe, exclusively as a living group in the Indo-Pacific, are typical instances of a large number of similar cases which at one time were thought to imply an easterly migration of the tertiary fauna of Europe into the Indo-Pacific region of the present day. It has now been shown that the great majority of these cases resulted from our hitherto deficient knowledge of the fossil contents of the tertiary formations of Asia, and, with increasing research, most of these supposed instances have now vanished.

It is clear, however, that amongst the minor divisions enumerated in the preceding list some have a well-defined geographical as well as geological distribution. The most archaic group, that of *Dolium crosseanum*, is entirely restricted at the present day as well as in former geological times to the Mediterranean and Atlantic region. It is, so far as our present information goes, the geologically oldest group, and that from which the other forms of *Dolium* seem to have been derived. It is possible therefore that the genus *Dolium* may truly have had a western origin. *Dolium*, s. str., as here understood, has not been found in a fossil condition in the west. *Dolium galea* is special to the Mediterranean and Atlantic. The other forms of *Dolium*, s. str., as here understood, are essentially Indo-Pacific, though *Dolium perdix* has also spread to the West-Indies and to the coast of Brazil, evidently through the former marine connection across Central America which has afforded a passage to other Indian species, either still living in the Indian region, or known in a fossil condition, as has already been pointed out in the publications of this Department (*Memoirs of the Indian Museum*, Volume VI, p. 124).

As already pointed out by Sacco (*Moll. dei terr. terz. del Piemonte e della Liguria*, Part VIII, 1891, p. 22), the occurrence throughout the pliocene of southern Europe of a *Malea* closely related to the tropical *Dolium* (*Malea*) *pomum* indicates the persistence, in the Mediterranean region, of a warm climate down to the very eve of the Glacial Epoch.

Amongst the additions to our knowledge of the distribution of these shells furnished by the Calcutta collection, one of the most interesting is that concerning the presence, at Maskat, of *Dolium variegatum*, hitherto only known from the Australian region and Japan. While there is every reason to believe that the distribution of *Dolium variegatum* at the present day is discontinuous, its occurrence in a fossil condition in the Mekran beds as also in Java furnishes an easy clue to its present occurrences, the distribution of the shell having been more extensive in former geological times than at the present day. Another species, *Dolium tessellatum* which, at the present day, does not appear to extend further west than the eastern part of the Bay of Bengal, also occurs in a fossil condition in the Mekran region. Just as in the case of *Dolium variegatum*, it seems now to have disappeared from the shores of the Indian Peninsula, only, unlike *D. variegatum*, it has also disappeared from the northern shores of the Arabian Sea. Consequently *D. tessellatum* does not exhibit at the present day the discontinuous distribution observed in the case of *Dolium variegatum*.

The following recent species are represented in the collections of the Indian Museum :—

- Dolium galea* (Linn.)
 „ *variegatum*, Lam.
 „ *chinense*, Dillw.
 „ *olearium*, Brug.
 „ *perdix* (Linn.)
 „ *maculatum*, Lam.
D. (Eudolium) tessellatum, Brug.
 „ *fasciatum* (Brug.)
 „ *zonatum*, Green.
D. (Malea) pomum (Linn.)
 „ *ringens*, Swains.

The only important species not represented are *Dolium melanostoma*, Jay, and the rare deep-sea forms *D. crosseanum*, Monterosato and *D. verrillii*, Dall, the latter of which is at present known only from a single specimen.

The following is a list of the specimens in the Indian Museum collection :—

***Dolium galea* (Linnæus).**

“Europe,” one specimen.

***Dolium variegatum*, Lamarck.**

Maskat, two specimens.

Port Jackson, one specimen.

Locality uncertain, five specimens, three of which are of very large size.

I have ascertained the presence of this shell also at Karachi.

As already mentioned, this species is also known in a fossil condition from the pliocene of Java, and of the Mekran.

***Dolium chinense*, Dillwyn.**

? Singapore, three specimens.

Locality uncertain, one large specimen, measuring 115×98 mm., coinciding exactly with the figured type of *Dolium magnificum*, Sow.

Also fossil in the upper miocene of Java.

***Dolium olearium*, Bruguière.**

Andamans, one specimen.

Nicobars, one specimen.

? Singapore, one specimen.

Trincomali, two specimens.

Locality uncertain, five specimens.

Dolium perdix (Linnaeus).

Andamans, four specimens.

Australia, one specimen.

Cocoa Islands, two specimens.

Mauritius, three specimens.

Gulf of Suez (*Capt. R. B. S. Sewell*, 8-1-1917), two specimens.

Trincomalee, four specimens.

Locality uncertain, three specimens.

Dolium maculatum, Lamarck.

Amboina, one specimen.

Andamans, three specimens.

Off the east coast of the Andamans (Lat. $13^{\circ}17'15''$ N., Long. $93^{\circ}10'25''$ E.), a dead shell dredged from a depth of 185 fathoms.

Arakan, one specimen.

Balasore Bay, three specimens (Bengal Fisheries, M $\frac{4295}{1}$, M $\frac{4408}{1}$, M $\frac{4410}{1}$).

Bombay and probably Kachh: four specimens (M $\frac{5395}{1}$).

Ceylon or Kachh, one large specimen.

Chandipore, one specimen.

Penang, one specimen.

Sandheads, one specimen, remarkable for its extremely sunken spire (*A. Milner*).

? Singapore, one specimen.

Tavoy coast, four specimens.

"Indian Seas," one large specimen.

Locality unknown, nine specimens.

I have ascertained the existence of this shell also at Puri.

In a fossil condition it is known from the pliocene formations of the Mekran and from the post-tertiary of the Pulicat Lake near Madras. *Dolium modjokasriense*, Martin, from the upper tertiary of Java, is perhaps identical.

Dolium (Eudolium) tessellatum, Bruguière.

Andamans, nine specimens, one of which is from the South Andaman.

Nicobars, one specimen.

Locality uncertain, five specimens.

Also fossil in the upper miocene and pliocene of Java and in the pliocene of the Mekran.

Dolium (Eudolium) fasciatum (Bruguière).

Balasore Bay, four specimens, including the type of *Dolium varicosum*, Preston.

Ceylon, two specimens.

Hongkong, two specimens.

Kachh, one specimen.

Vizagapatam, one specimen.

Vizagapatam, one specimen (*Moti Ram*).

Vizagapatam, between Dolphin's Nose and Scandal Point, 18 Jan.—17 June, 1916
(*Rev. H. Hosten*, S.J.), two specimens.

Locality uncertain, six specimens.

This shell also occurs at Puri.

***Dolium (Eudolium) zonatum*, Green.**

Hongkong, three specimens, one of which is a very large shell with a super-numerary varix.

Locality uncertain, one specimen.

Also represented by a fossil variety in the pliocene of Java.

***Dolium (Malea) pomum* (Linn.).**

Andamans, four specimens.

Kachh, two specimens.

Laccadives, one specimen.

Maldives, one specimen.

Mauritius, one specimen.

Singapore, one specimen.

Locality uncertain, six specimens.

***Dolium (Malea) ringens* (Swainson).**

Panama, three specimens.

Genus ***Pirula*** (Lamarck, 1799), Sowerby, 1823.

(= *Ficula*, Swainson, 1840).

The Indian Museum collections contain the following species:—

<i>Pirula reticulata</i> , Lam.	} Group of <i>P. reticulata</i> .
„ <i>papyratia</i> , Say	
„ <i>tessellata</i> , Kobelt	
„ <i>decussata</i> , Wood	
„ <i>dussumieri</i> , Val.	
„ <i>ficus</i> (Linn.)	
„ <i>investigatoris</i> (Wood-Mason and Alcock), E. A. Smith.	

The genus seems therefore to be complete as these are apparently the only well-defined species known living.

Unlike the genus *Dolium*, which seems to have reached the climax of its development at the present day and is not known in formations older than the middle tertiary (oligocene), the greater number of fossil representatives being upper miocene and pliocene, *Pirula* is known from cretaceous times, and the fossil species are more numerous than the recent ones. A complete review of the genus such as was attempted in the case of *Dolium* would belong therefore more to the province of palæontology

than to that of modern zoology, and would include several groups without any modern representatives. In any case a general idea of the phylogeny of the genus is as yet unattainable owing to our deficient knowledge of the earlier tertiary faunas of the east.

It will be noticed that the majority of the living species belong to a single group, which may be distinguished as the group of *Pirula reticulata*, ancestral forms of which are known as early as the middle eocene of Europe. *Pirula investigatoris* belongs to a group of which the earliest known representative, *Pirula concinna*, Beyrich, has been observed in the oligocene both of Germany and of Burma; a second fossil form, *Pirula pamotanensis*, Martin, occurring in the lower miocene of Java and of Kachh. The ancestry of *Pirula ficus* is at present quite unknown, and is perhaps of eastern origin.

With regard to the substitution by Swainson, in 1840, of the name *Ficula* instead of *Pirula* under pretext of the want of homogeneousness of Lamarck's genus, it is to be observed that as early as 1823, Sowerby (*Genera of Shells*) had already circumscribed *Pirula* within exactly the same limits as Swainson's *Ficula*, giving, as the living type, a figure of a shell which is referred to *Pirula reticulata*, Lamk., but which really represents *P. papyratia*, Say, while *P. tricarinata*, Lamk. and *P. burdigalensis*, Sow. are figured as examples respectively of the earlier and later fossil forms.

The following is a list of the specimens in the Indian Museum collections:—

1. *Pirula reticulata*, Lamarck.

Bimlipatam (*Wood-Mason*), two specimens.

Hong-Kong, two specimens remarkable for their exceptionally prominent spire. I have carefully examined them and ascertained that they are not, as might be thought, immature specimens of *Pirula dussumieri*.

Laccadive sea, Station 248 (8°37' N., 75°37'30" E.), at a depth of 224–284 fathoms, in sand. (M ²⁰⁰₁). One specimen.

Malabar coast, 45 fathoms, Marine Survey, 1891–2 (No. ²⁹¹₉), two specimens.

Maldives, two specimens.

In Lagoon of Northern Maldivé Atoll (Station 148), 15–30 fathoms, in sand, shells, and corals, one specimen.

Persian Gulf, one specimen.

Sind, one specimen.

Vizagapatam, between Dolphin's Nose and Scandal Point (*Rev. H. Hosten*, S.J.) 18-1—17-6-16. One specimen.

"Indian seas," three specimens of uncertain locality, No. 2588.

Locality unknown. One fine specimen, No. 2590.

The species is also known in a fossil condition from the tertiary of Karikal and of Java; also of Europe.

2. *Pirula papyratia*, Say.

Florida, four specimens, No. 2597.

3. *Pirula tessellata*, Kobelt.

Australia, two beautiful specimens, No. 259.

4. *Pirula decussata*, Wood.

Panama, two specimens.

5. *Pirula dussumieri*, Valenciennes.¹

Pirula dussumieri was originally described from Chinese specimens. In the present collection the Hong-Kong specimens are larger than those from the Bay of Bengal.

Balasore Bay, Bengal Fisheries, M $\frac{4412}{1}$, M $\frac{4294}{1}$, two specimens.

Bay of Bengal (20°18' N., 90°50' E.), 65 fathoms, Marine Survey (5337, $\frac{4123}{1}$), three specimens, of which one in spirit.

Bimlipatam (*J. Wood-Mason*), No. 2591, two specimens.

Hong-Kong, three splendid specimens.

Persian Gulf, Station 294, Marine Survey, No. $\frac{1310}{1}$ (26°33' N., 52°23' E.), 40 fathoms, mud and sand, one specimen in spirit.

Persian Gulf, Station 296, Marine Survey, No. $\frac{1315}{1}$ (26°4' N., 56°2' E.), 47 fathoms, mud and sand; one specimen in spirit.

East of Puri, Orissa Coast, Station 69, Marine Survey, $\frac{611}{1}$, $\frac{612}{1}$ (19°49' N., 86°31' E.), 46-50 fathoms, in mud; two specimens.

Sandheads, Gangetic delta, two specimens in spirit.

The species is also known fossil from the tertiary of Java.

6. *Pirula ficus*, Linnæus.

Hong-Kong, two specimens.

Kachh, two specimens.

Madras, four specimens.

Negapatam, two specimens.

Orissa Coast, Bengal Fisheries, M $\frac{4311}{1}$, one specimen.

"Puri," two specimens without any mark, in a box labelled "Puri," which originally contained nine other specimens either from other localities or of uncertain origin. Another box also labelled "Puri," and with the register slip 2589, did not contain a single specimen certainly obtained from that locality. Nevertheless the species does occur at Puri.

¹ Sacco refers to a shell, presumably identical with *Pirula dussumieri*, under the name of "*Ficula gracilis*, Crosse (Sowerby)" (*Moll. terr. terz. Piem. e Lig.*, Part VIII, p. 32), without quoting the authority for this correction, for which I had hoped to find an explanation in the *Journal of Malacology* for 1894 (Vol. III, p. 67) which is unfortunately not available in India. Presumably, it may be a name retrospectively proposed by Sowerby for the shell represented in fig. 1 of the "*Genera*," where it was erroneously referred to *Pirula reticulata*. The figure, however, represents *Pirula papyratia*, Say, named in 1822 (*Journ. Philad. Acad.*, Vol. II, p. 238), earlier therefore than Sowerby's correction, whatever may be the date of the latter. *Pirula papyratia* was again described as *P. gracilis* by Philippi in 1848 (*Zeitschrift für Malak.*, Vol. V, p. 97), the repetition of Sowerby's appellation being presumably a coincidence. In conclusion, the appellation *gracilis* is liable to give rise to confusion, while the meaning of *P. dussumieri* is perfectly definite.

Singapore, one specimen.

Tavoy Coast (*Museum Collector*), No. 358, one specimen.

Vizagapatam, between Dolphin's Nose and Scandal Point (*Rev. H. Hosten, S.J.*), 18-1—17-6-16, one specimen.

Vizagapatam, one specimen.

Locality uncertain, one specimen marked AS, and four marked with a query ; in a box labelled "Puri," with the register number 2589.

The species also occurs fossil in the tertiary of the Mekran, of Ramri Island, and of Java.

7. ***Pirula investigatoris*** (Wood-Mason & Alcock), E. A. Smith.

Ann. and Mag. Nat. Hist., (6) XIV, 1894, p. 367 ; *Illustrations of the Zoology of the Investigator*, 1897, pl. vi, fig. 2.

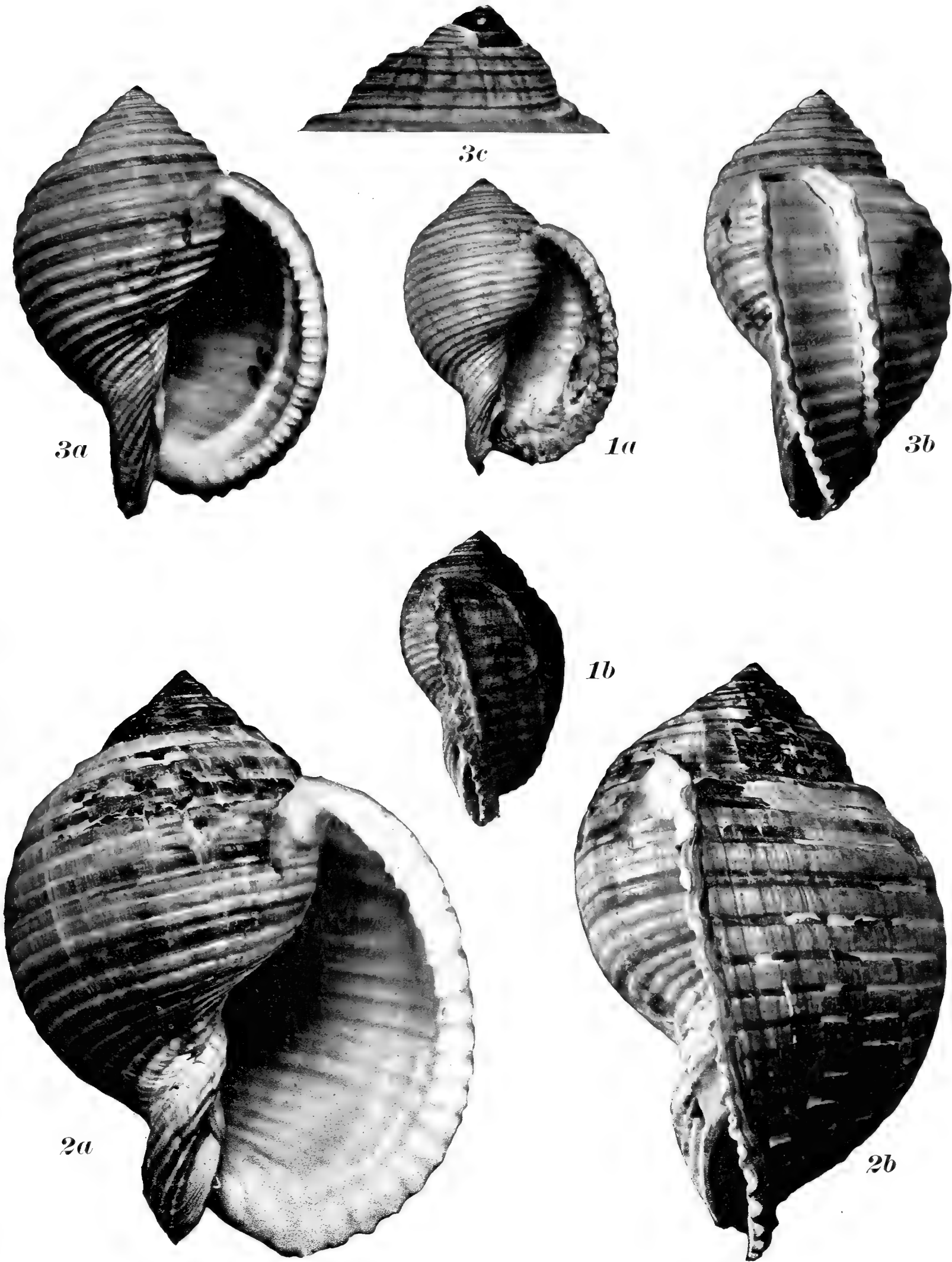
Bay of Bengal, Station 166 ($13^{\circ}34'55''$ N., $80^{\circ}32'12''$ E.), 133 fathoms, in brown mud, Marine Survey No. $\frac{744}{1} - \frac{745}{1}$, two specimens in spirit.

Ganjam Coast, Station 96 ($18^{\circ}30'$ N., $84^{\circ}46'$ E.), 98-102 fathoms, in sand, Marine Survey, No. $\frac{281}{1}$, $\frac{6161}{9} - \frac{6162}{9}$, two specimens, one very large.

Laccadive Sea, Station 258 ($8^{\circ}23'$ N., $76^{\circ}28'$ E.), 102 fathoms, in sand, M $\frac{768}{1} - \frac{770}{1}$, four specimens.

EXPLANATION OF PLATE II.

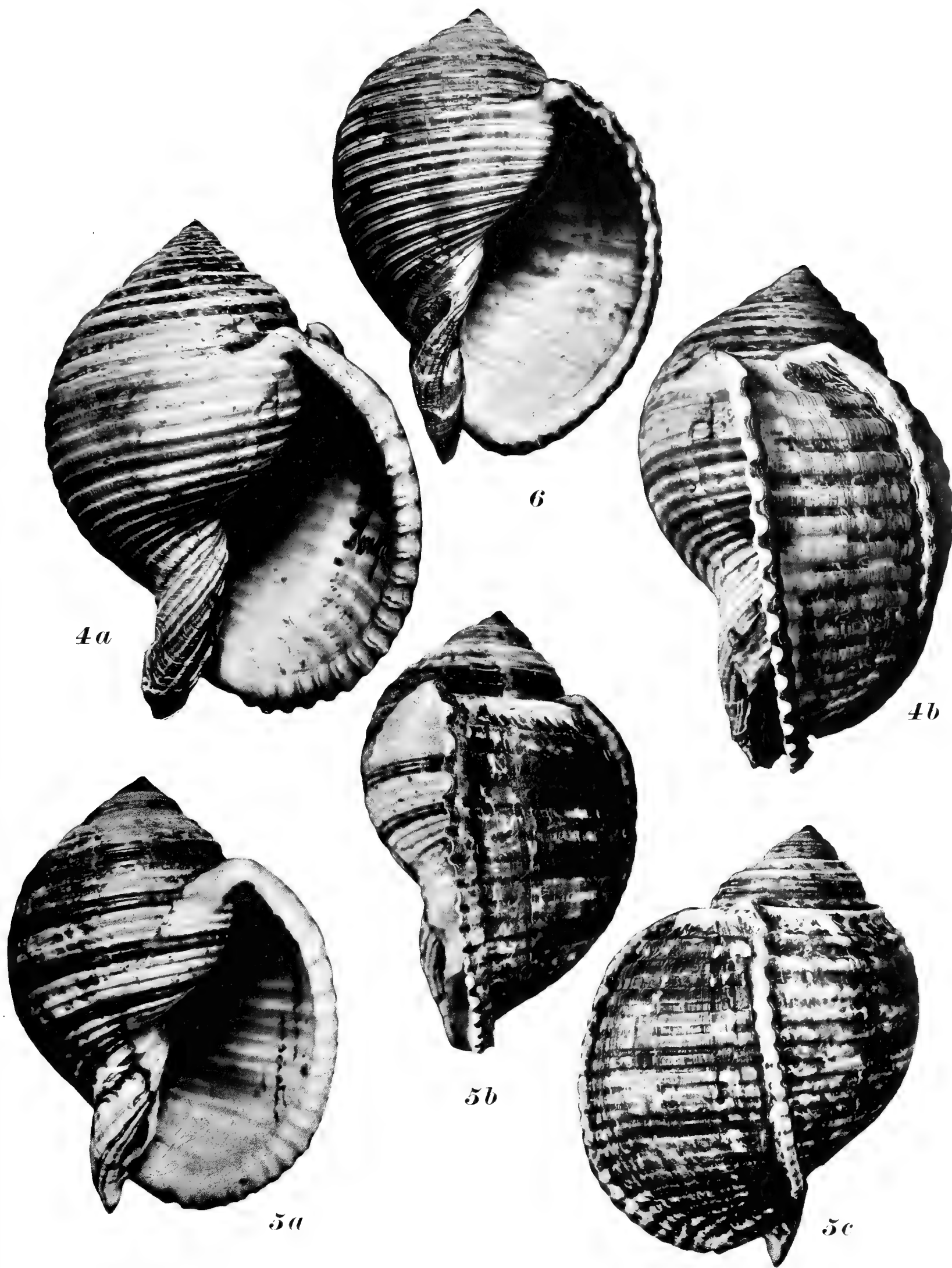
- FIG. 1, *a, b*.—*Dolium fasciatum* (Brug.). Balasore Bay (M $\frac{4411}{1}$). Original type
of *Dolium varicosum*. Natural size.
- ,, 2, *a, b*.—*Dolium fasciatum* (Brug.). Balasore Bay (M $\frac{4292}{1}$). Natural size.
- ,, 3, *a, b, c*.—*Dolium fasciatum* (Brug.). Varicose specimen of uncertain
origin ; *a, b*, natural size ; *c*, apex enlarged.



SHELLS OF DOLIUM.

EXPLANATION OF PLATE III.

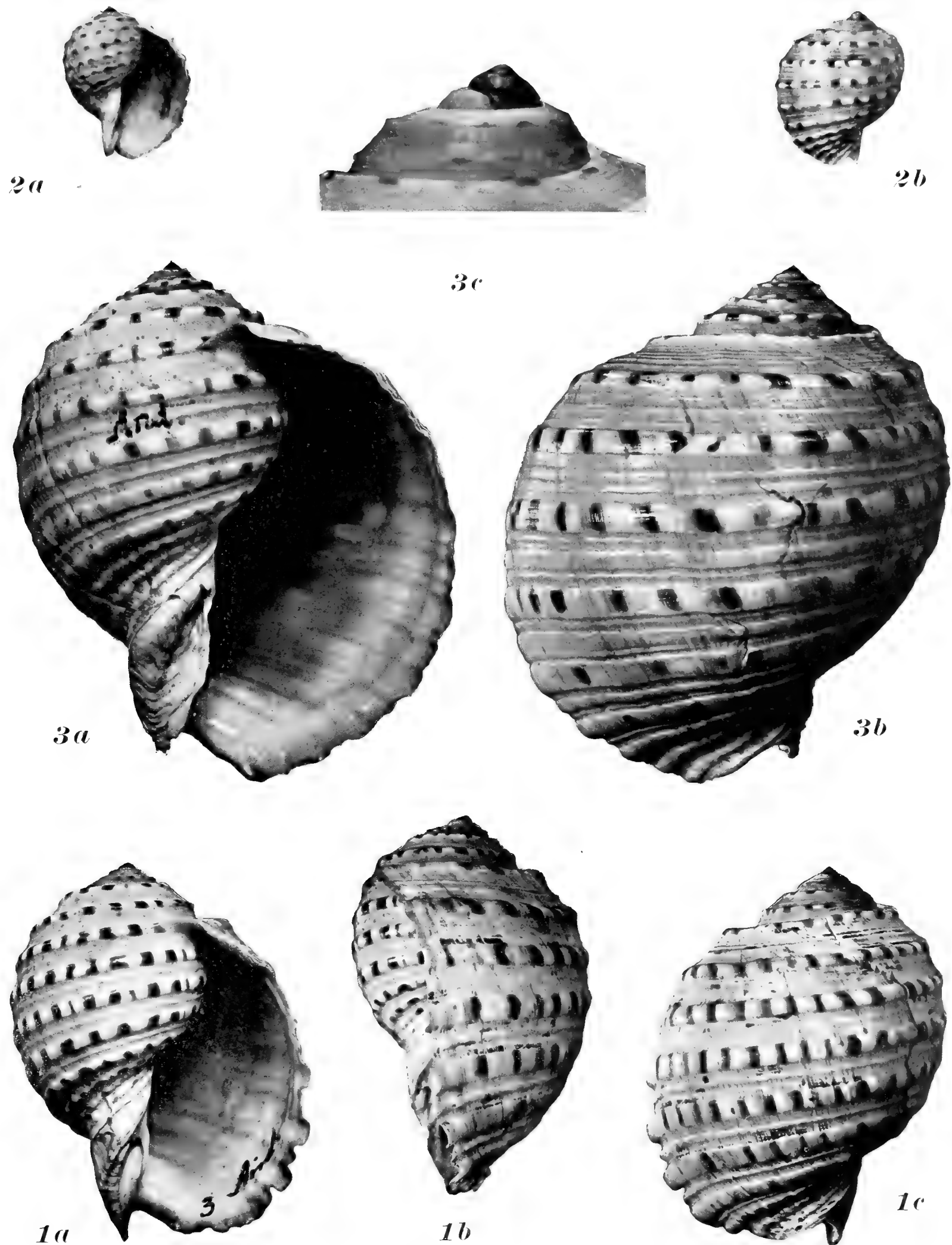
- FIG. 4, *a, b*.—*Dolium fasciatum* (Brug.). Varicose specimen from Hong-Kong.
Natural size.
- „ 5, *a, b, c*.—*Dolium fasciatum* (Brug.). Varicose specimen from Vizaga-
patam. Natural size.
- „ 6.—*Dolium zonatum*, Green. Hong-Kong. Natural size.



SHELLS OF DOLIUM.

EXPLANATION OF PLATE IV.

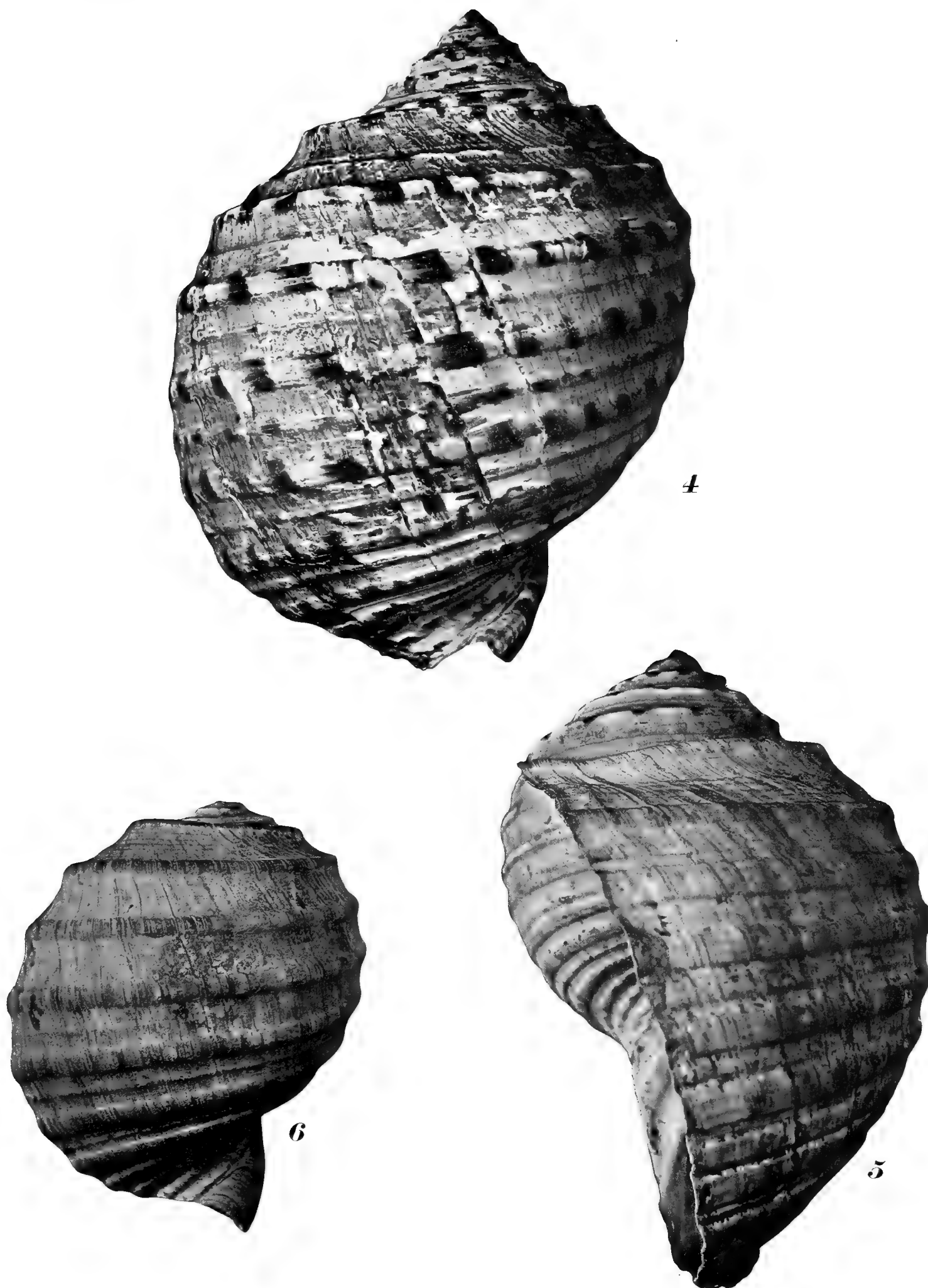
- FIG. 1, *a, b, c.*—*Dolium maculatum*, Desh. Andamans; specimen with fully formed aperture. Natural size.
- „ 2, *a, b.*—*Dolium maculatum*, Desh. Immature specimen; Andamans. Natural size.
- „ 3, *a, b, c.*—*Dolium maculatum*, Desh. Large specimen showing adult character of ornamentation; Andamans; *a, b*, natural size; *c*, protoconch enlarged.



SHELLS OF DOLIUM.

EXPLANATION OF PLATE V.

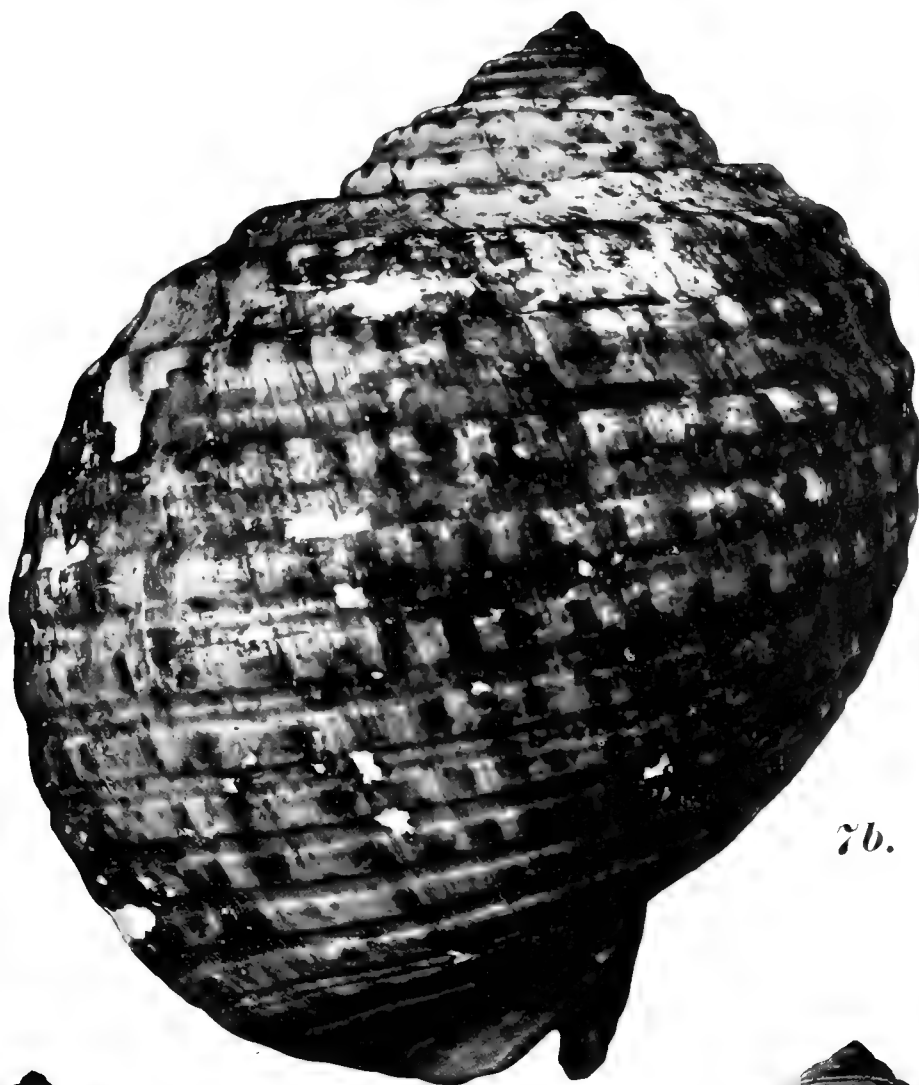
- FIG. 4.—*Dolium maculatum*, Desh. Large specimen with persistent juvenile character of the ornamentation. Balasore Bay (Bengal Fisheries M $\frac{41.08}{1}$). Natural size.
- „ 5.—*Dolium maculatum*, Desh. Specimen with adventitious supernumerary main rib. (?) Ceylon. Natural size.
- „ 6.—*Dolium maculatum*, Desh. Specimen with extremely depressed spire. Sandheads. Natural size.



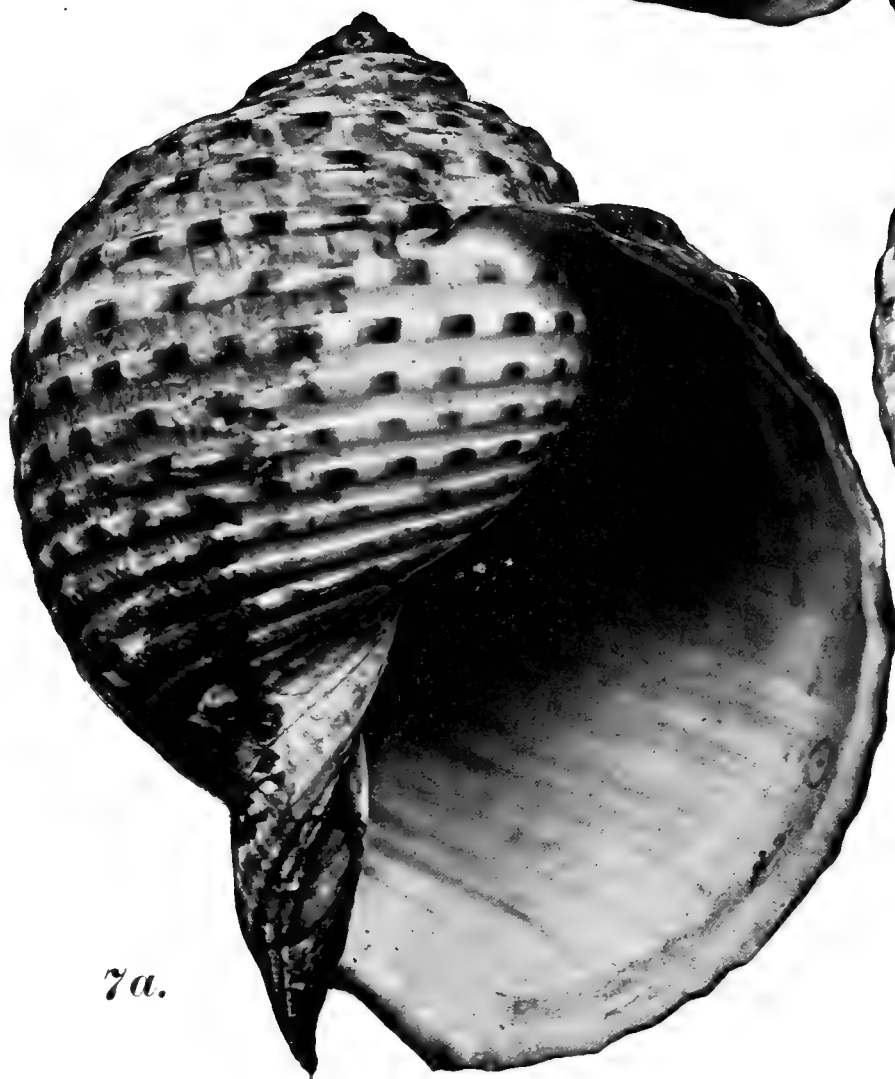
SHELLS OF DOLIUM.

EXPLANATION OF PLATE VI.

FIG. 7, *a, b, c.*—*Dolium tessellatum*, Brug. Large specimen showing adult characters. Andamans. Natural size.



7b.



7a.

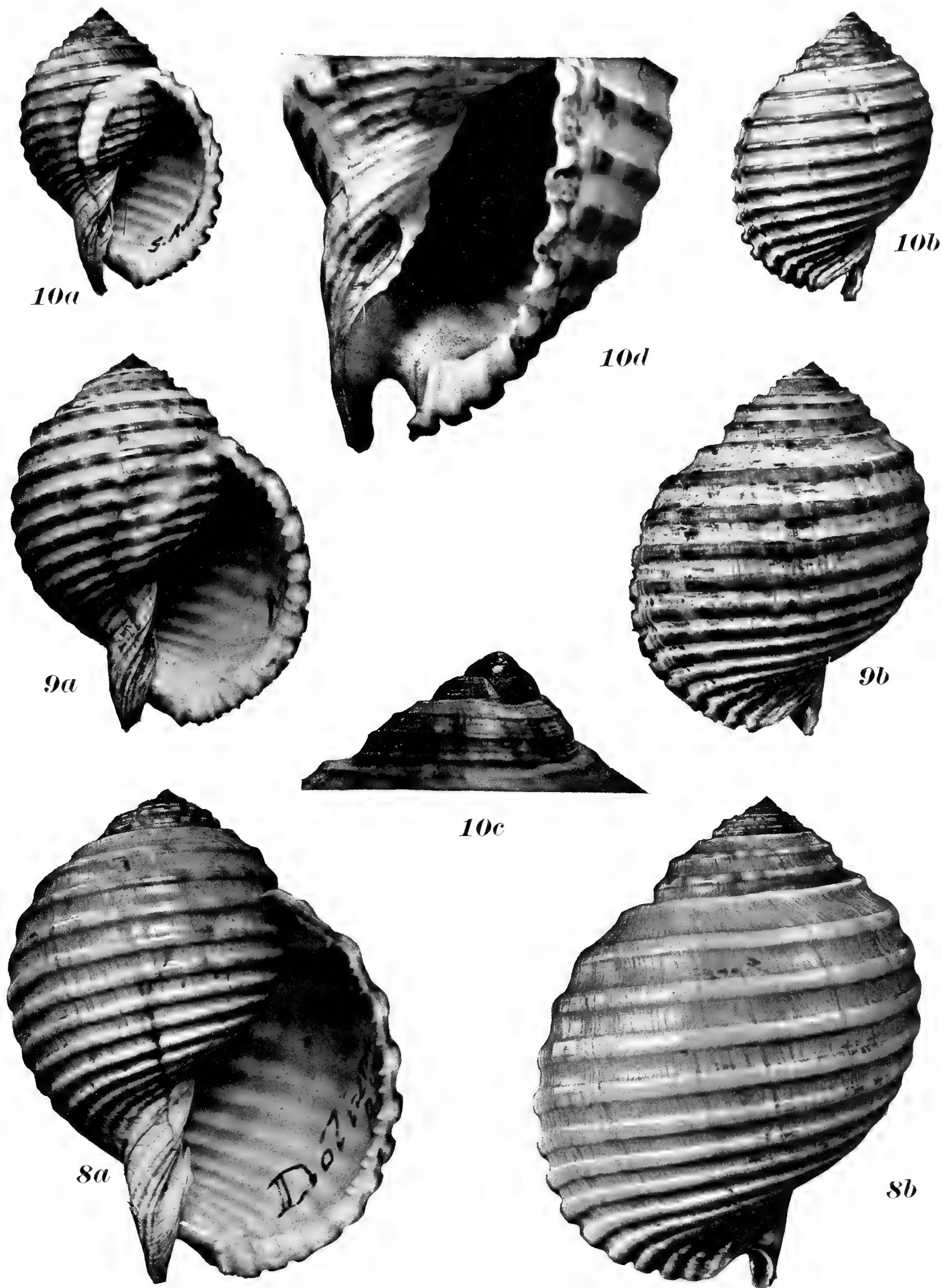


7c.

SHELLS OF DOLIUM.

EXPLANATION OF PLATE VII.

- FIG. 8, *a, b*.—*Dolium tessellatum*, Brug. Andamans. Natural size.
,, 9, *a, b*.—*Dolium tessellatum*, Brug. Small specimen. Andamans. Natural size.
,, 10, *a, b, c, d*.—*Dolium tessellatum*, Brug. South-Andaman; *a, b*, natural size; *c*, protoconch enlarged; *d*, columella enlarged to show the columellar rugosities.



SHELLS OF *DOLIUM*.

EXPLANATION OF PLATE VIII.

- FIG. 11, *a, b*.—*Dolium tessellatum*, Brug. Immature specimen. Andamans.
Natural size.
- „ 12, *a, b*.—*Dolium tessellatum*, Brug. Immature specimen of uncertain origin,
with fully developed outer lip. Natural size.
- „ 13, *a, b, c*.—*Dolium tessellatum*, Brug. Specimen of uncertain origin, with
exceptionally depressed spire. Natural size.



12a



12b



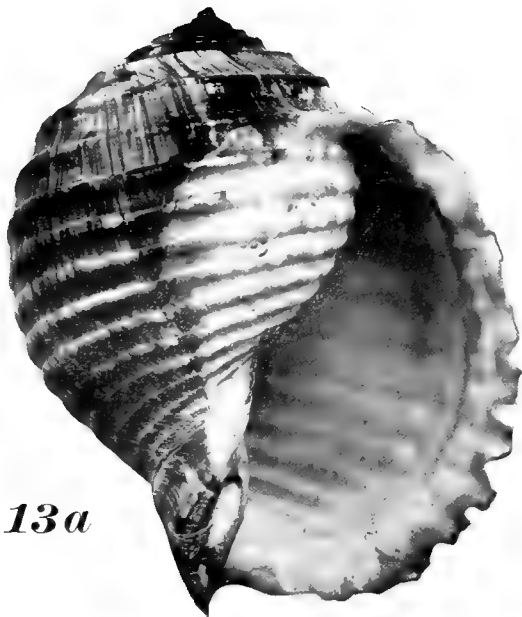
13c



11a



11b



13a



13b

SHELLS OF DOLIUM.

MEMOIRS OF THE INDIAN MUSEUM

Vol. VII, No. 3.

ON A COLLECTION OF OLIGOCHAETA FROM THE LESSER KNOWN PARTS OF INDIA AND FROM EASTERN PERSIA.

BY

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(With Plates IX -XI.)

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INTRODUCTION.

The following fairly extensive investigation is based on material from a number of sources :—

- (i) By far the largest portion consists of a collection made by Dr. Baini Prashad in Central and Western India in June and July, 1917. These were the regions of India about whose earthworm fauna we knew least; and Dr. Prashad very kindly at my suggestion gave up a month of his vacation to making the collection. My best thanks are due to him for the expenditure of so much time, and for the large amount of labour involved in visiting so many different localities. The other collections are much smaller, and comprise—
- (ii) One from Seistan and certain localities in the North-West Frontier Province and the Punjab, made by Dr. Annandale and Mr. S. W. Kemp in the course of their mollusc survey in Nov., 1918—Jan., 1919; this consists largely of fresh-water worms.
- (iii) One from the Western Ghats, also of small fresh-water worms, by Dr. Annandale in March, 1918.
- (iv) One from Rajputana in 1918, by the Agent to the Governor-General, Col. J. Manners-Smith.
- (v) A number of tubes brought back by Dr. Baini Prashad from the Natural History Society of Bombay.
- (vi) A small collection from the Garo Hills in Assam, by Mr. Kemp, in July-August, 1917.

- (vii) One from the Darjiling District in the Eastern Himalayas, by Drs. Annandale and Gravelly in October, 1917.
- (viii) A few specimens from Shillong in Assam, collected by Dr. Annandale in April, 1918.
- (ix) A few specimens sent at various times from Lucknow by Mr. G. S. Thapar.

The collections, including the types of new species, are now in the possession of the Indian Museum, with the exception of a few tubes which I am retaining for histological work in the future.

A considerable number of the species encountered are new, as was to be expected from the fact that the territory explored was mostly new or little worked. I have also met with a number of species previously described by other workers from single or ill-preserved specimens, and have sometimes been able to improve our knowledge of them. It can scarcely be said however that the results of the present investigation include anything of the first order of importance,—it is now too late to expect this. There are notable additions to the genera *Perionyx*, *Octochaetus*, and *Eudichogaster*. *Perionyx* must now be held to have a definite territory of its own in Western India, in addition to its head-quarters in the E. Himalayas; *Octochaetus* is to be recognized as an endemic and dominant genus in West and Central India; the limits of the *Eudichogaster* territory however remain where they were established by Michaelsen in 1909 (3). *Eudichogaster* is the characteristic earthworm of Central India. New species of *Perionyx* will still be brought from the Himalayas; new species of *Megascolex* from the South, and of *Eudichogaster* from Central India; but the main features of the Indian earthworm fauna are now fairly well defined.

Perionyx sansibaricus turns out to be one of the common earthworms of Western India, whence doubtless it was transferred to Zanzibar, where it was first found.

The new *Hoplochaetella* raises some interesting points of morphology and phylogeny, and helps to show,—what is illustrated by other parts of the paper also, and indeed, I suppose, by the experience of systematists in general,—that the smaller our material, the more precise and satisfactory is our systematic work. Here as elsewhere increase of knowledge brings sorrow and trouble, and where before we walked confidently as in the daylight, we hesitate and feel befogged.

I have previously had several opportunities,—more, perhaps, than have fallen to the lot of other workers,—of examining the curious gilled *Branchiura sowerbyi*, and have been interested in meeting it once again, this time from Lucknow. Though several workers (Beddard, Michaelsen, and myself) had previously sectioned the animal, the possibility of the protrusion of the ectal portion of the atrium as a relatively long penis was not suspected until recently. Several of the specimens from Lucknow had both penes protruded and visible on the surface.

A new *Megascolides* from the Western Ghats, and a previously imperfectly known *Glyphidrilus* now found at Lucknow, are interesting in view of the rarity of these genera in India. A *Drawida*, of a distinct variety, is one of the common worms of Bombay City and neighbourhood; the genus is otherwise almost confined to the South and to the E. Himalayas.

Fam. NAIDIDAE.

Genus *Chaetogaster*.*Chaetogaster bengalensis*, Annand.

Five miles S.E. of Nasratabad, Seistan, E. Persia. Small pool in the desert; water fresh but turbid, bottom muddy with a fairly rich growth of *Potamogeton* and reeds, mostly in a dying condition. The specimens were on *Limnaea gedrosiana* var. *rectilabrum*, Annand. and Prashad, 26-xii-1918. N. Annandale and S. W. Kemp.

Peshawar, N.-W.F.P.; on *Limnaea acuminata*. 12-i-1919. N. Annandale. Several specimens.

Kalpani stream, near Nowshera, N.-W.F.P.; on *Limnaea acuminata*. 13-i-1919. N. Annandale. Four specimens.

Madhopur, Gurdaspur District, Punjab; on *Limnaea acuminata*. 27-i-1919. N. Annandale. Forty-nine specimens taken out of the mantle cavity of a single individual of *Limnaea*.

Satara Fort, W. Ghats; ca. 3,300 ft. 4-iii-1918. N. Annandale. On *Limnaea chlamys*, Benson.

The specimens from the Western Ghats and from Seistan were examined in some detail.

There is sometimes, in preserved specimens, a constriction between the pharyngeal region and the rest of the body. The length of the setae of segment ii is commonly 120μ , of the rest 60μ . In all the batches, 15 and 16 setae were quite commonly found in a single bundle.

The appearance of the "crop" is rather characteristic, owing to its complete investment of chloragogen cells. These have the arrangement of paving stones, lying side by side, and well demarcated from each other by linear intervals. The entrance to the crop is marked, as in the specimens from the Inlé Lake (14), by a ring of tall cells which project into the lumen.

The lateral commissural vessels in the oesophageal region are never swollen or heart-like. The dorsal vessel, on the other hand, is often dilated just behind the origin of these commissures.

The species appears to have a wide distribution, and to be the prevailing commensal of *Limnaea*. It thus takes the place in India of *C. limnaei*, which is found in a similar association in Europe; Michaelsen has however found *C. limnaei* on a specimen of *Limnaea* from the Kumaon District (Central Himalayas) (3). Last year I identified several specimens from a sponge (*Ephydatia fluviatilis*) from the Inlé Lake as doubtfully belonging to *C. limnaei* (14); through the kindness of Dr. Annandale I have recently had the advantage of comparing my examples of this form with a specimen of *C. limnaei* sent to the Indian Museum by Dr. J. H. Ashworth of Edinburgh; but I am still unable to say definitely that the Inlé worms either are or are not *C. limnaei*. The identification of these small worms from preserved material only is, as I have previously explained (12), often both difficult and extremely hazardous.

Chaetogaster spongillae, Annand.

Khandala, W. Ghats; from sponge (*Spongilla crateriformis*) in artificial tanks made by damming stream; bottom,—mud over rocks; some stones; weeds fairly abundant. 6-iii-1918 N. Annandale.

The length of a chain of two individuals was from .47 to .7 mm., the diameter .15 mm. The head is relatively small in this species, and, as has previously been described, the upper lip projects forwards in front of the mouth, forming a short prostomium. There is a slight constriction between the pharyngeal region and the rest of the body. The number of setae in the first bundle was five or six, in those that follow four, and towards the hinder end three or fewer. I could not detect any difference in the thickness of the terminal prongs (in a previous description I have noted the distal prong as being the thinner); the length and other proportions are the same as those I formerly gave (7). Chloragogen cells are absent on the crop. $n = 8$, as before.

Chaetogaster punjabensis, Stephenson (?).

Nasratabad, Seistan, E. Persia; water-channel in Consulate Garden. Nov. and Dec. 1918. N. Annandale and S. W. Kemp.

A single specimen was found among a number of examples of *Nais communis* var. *punjabensis* in association with colonies of the Polyzoon *Lophopodella* (see below). The association was no doubt quite fortuitous.

Here again it is impossible to speak with certainty; the small size, and distinct and relatively long oesophagus of the specimen, are characteristics of *C. punjabensis*. The numbers of setae per bundle appear to be rather smaller here, and I could not follow the dorsal and ventral vessels forwards beyond the anterior end of the crop in a glycerine mount of the specimen; I also failed to distinguish any refractile body in the cerebral ganglion, though this is a notable feature, at least of living specimens.

The specimen was in a late stage of sexual maturity; the clitellum was present, and there was a mass of ova in the middle of the body; the animal was much swollen in this middle region. In the Punjab the Naid worms mostly become sexual at the beginning of the hot weather,—April and May; but this specimen was taken in Seistan in the early part of the cold weather.

Genus **Nais**.

Nais communis, Piguet var. **punjabensis**, Stephenson.

Nasratabad, Seistan; water-channel in Consulate Garden; water fresh but turbid, bottom muddy with a scanty growth of weeds. Nov. and Dec. 1918. N. Annandale and S. W. Kemp. Numerous specimens.

Open pool in the reed-beds of the Hamun-i-Helmand, a few miles east of Lab-i-Baring, Seistan. Water very slightly brackish, fairly clear, about five feet deep; bottom muddy with a luxuriant growth of *Potamogeton pectinatus*. 8-xii-1918. N. Annandale and S. W. Kemp. Three specimens.

Peshawar, N.-W.F.P.; on *Limnaea acuminata*. 12-i-1919. N. Annandale. A single specimen.

Khandalla, W. Ghats; in algae on cliff kept wet by spray of a small waterfall.¹ 7-9-iii-1918. N. Annandale. Two tubes, five specimens in one, four in the other.

¹ N. Annandale, *Rec. Ind. Mus.* XVI, p. 121 (1919).

The specimen from Peshawar occurred along with *Chaetogaster bengalensis*; its presence in this association was probably accidental.

Dr. Annandale's note on the worms from Nasratabad runs:—"Oligochaetes in relatively long mucilaginous tubes intertwined with stems of weed. A colony of the Polyzoan *Lophopodella* attached to each tube." Of the two glass tubes in which the Nasratabad specimens were sent to me, one contained worms only, the other some fragments of weed, and several colonies of *Lophopodella*, each attached to a soft brownish tube. I found the worms on the fragments of weed, but there were none still remaining in the tubes to which the Polyzoan colonies adhered. I have found this worm in numbers in tubes in Lahore (5), but the tubes in this case were apparently those of insect larvae, not manufactured by the worms themselves.

The specimens from the Western Ghats are possibly a separate variety. The dorsal needles are in the var. *punjabensis* finely forked; though barely or not at all distinguishable with the ordinary high power, the forking is quite evident on examination with the oil immersion, when the needles lie in a favourable position. In these specimens I thought I detected a trace of bifurcation in a few cases on close observation, but in many the forking seemed quite definitely to be absent.

***Nais paraguayensis*, Mehlsn.**

Plate IX, fig. 1.

Gwalior, Central India; in a pond, attached to *Hydrilla* and other debris; 18-vi-1917. B. Prashad. Three specimens.

This species has previously been recorded from Calcutta and from Sirsiah in Bihar by Michaelsen, and from Lahore by me. The species seems to be rather variable. The present specimens were from 4.5 to 7.5 mm. in length, and consisted of from 29 to 56 segments, without any sign of a budding zone. The ventral setae are three or four per bundle; in the body generally the prongs are equal in length, but the outer is only two-thirds or even half the thickness of the inner. In the first four seta-bearing segments both prongs seem to be longer and thinner than in more posterior segments, but the relative thicknesses are maintained; the outer prong is slightly longer than the inner; the shaft is also slightly thinner than in succeeding segments.

The dorsal bundles consist usually of one hair and one needle; two needles may occur, and also two hairs, in which case one is much shorter than the other. There are slight variations from the typical form among the needles; in one case the smaller outer prong was itself bifid; in another the longer prong was slightly bent outwards towards the smaller; in one specimen the outer prong was regularly very short (fig. 1, *a* and *b*).

var. *aequalis*, var. nov.

Plate IX, fig. 2.

Saugor, Central Provinces; in a large lake, attached to leaves. 20-vi-1917. B. Prashad. A single specimen, in spirit, and one preserved and flattened in glycerine on a slide at the time of capture.

The spirit specimen is 3.5 mm. in length, and .23 mm. in thickness; it has 34 segments, with a short region posteriorly in which segments are not yet differentiated. There is no budding zone.

The prostomium is moderately large and long; its length is equal to its breadth at the base, and it is rounded anteriorly. There are no eyes. The anus is dorsal.

The dorsal setal bundles begin in segment vi. They consist of one hair and one needle seta,—never more than one of either. The hairs have approximately a length equal to the diameter of the body. The needles are slightly sickle-shaped (fig. 2), and forked distally; when the seta is in a good position for observation this can be seen with the ordinary high power. The prongs are of the same length (the outer may possibly be the least trifle longer), and join at an acute angle; the outer seems to be slightly thinner. In length these needles are 52μ , in thickness 2.5μ .

The ventral setae are of the usual type, and are usually 4 per bundle; 3 and 5 were also met with. In length they are 52μ , in thickness 2.5μ . The inner prong is of equal length with the outer, but is twice as thick. I cannot see any difference of type between the setae of segments ii—v and the rest; but unfortunately the one specimen is fixed in such a position that these setae can be seen well from neither side, and the other (the already mounted specimen) seems to be the just separated posterior animal of a chain, in which the anterior segments have not yet fully developed.

There is no stomach. Coelomic corpuscles are present. The cerebral ganglion is bifid both anteriorly and posteriorly, and consists of two more or less independent halves, contiguous for some distance along their inner borders.

In the typical form of *N. paraguayensis* the outer prong of the dorsal needles is considerably shorter than the inner, while in these specimens it is of equal length. As however there appear to be no other essential differences, it will, I think, be sufficient to describe them as a variety.

***Nais pectinata*, Stephenson.**

Gwalior, Central India; in a pond, attached to *Hydrilla* and other debris. 18-vi-1917.

B. Prashad. A single specimen.

The specimen agrees generally with those previously described from Bheemanagar, Travancore (6). Since the presence or absence of a stomachal dilatation is one of the few internal marks that are used as specific characters in this genus, I may supplement the original description by adding that there is none in this species.

***Nais gwaliorensis*, sp. nov.**

Plate IX, figs. 3, 4.

Gwalior, Central India; in a pond, attached to *Hydrilla* and other debris. 18-vi-1917.

B. Prashad. A single specimen.

The specimen is in length 2.7 mm., in thickness .25 mm. There are 29 segments with a small zone behind where segments are not yet differentiated. There is no zone of budding. The prostomium is bluntly triangular, its length being equal to its base. Eyes are absent. There is also no stomachal dilatation on the alimentary canal.

The dorsal setae begin in segment vi, and each bundle consists usually of one hair and one needle seta; two hairs are sometimes found, in which case one is shorter and thinner than the other; once two hairs and two needles were seen,—the one couple may perhaps have been destined to replace the other when they fell out.

The hair is as a rule not quite equal in length to the diameter of the body. The needles are about 45μ in length (hardly any can be measured accurately, owing to their not lying flat), and bent at a very obtuse angle at a point rather distal to the middle (fig. 3). The distal section of the seta is slightly curved in the contrary direction,—very slightly only, so that the whole can hardly be described as sickle-shaped. There is an indefinite nodulus at the angle in the shaft; the length of the distal to that of the proximal section of the shaft is about as 2 to 3. The tip is bifid, the two prongs being visible to the ordinary high power of the microscope; the angle between the two prongs is moderately wide, and the outer, which continues the direction of the shaft, is slightly longer and perhaps slightly thinner than the inner.

The ventral bundles, in all segments from vi onwards, consist of four or five setae, $45\text{--}53\mu$ in length and 2.5μ in thickness (fig. 4a). The nodulus is distal; its exact position on the shaft probably varies in the several setae of a bundle (*cf.* Stephenson, 10), though I was not able to obtain exact measurements. The prongs are equal in length, the outer is not swollen at the base, and is only half or two-thirds as thick as the inner.

In the first four seta-bearing segments the form differs somewhat. The shafts of the setae are thinner and straighter; the nodulus is about the middle or a little proximal to the middle of the shaft; the outer prong is $1\frac{1}{4}$ times as long as the inner, two-thirds as thick at the base, and more hooked (fig. 4b). There are four setae per bundle; their length is 50 to 56μ , and their thickness only 2μ .

Remarks:—The species to which the present comes nearest are *N. tenuidentis* (Walton, 15) and *N. raviensis* (Stephenson, 9). The distinguishing character of the former is the very long and slender prongs of the ventral setae,—hence its specific name. The separation of the present form from *N. raviensis* depends on the characters of the setae, both dorsal and ventral; the differences will be best realized by comparing the figures given in the present paper with text-fig. 1 of my description of *N. raviensis*. The most obvious are the position of the bend of the shaft of the dorsal needles (much nearer the middle here), the relative lengths of anterior and posterior ventral setae (the anterior are nearly twice as long as the posterior in *N. raviensis*), and the characters of the prongs of the anterior ventral setae (in *N. raviensis* the outer is very much the longer, and makes a very narrow angle with the inner).

Genus *Pristina*.

Pristina longiseta, Ehrbg.

Gwalior, Central India; in a pond, attached to *Hydrilla* and other debris. 18-vi-1917. B. Prashad. One complete specimen, and perhaps one or two more in which the characteristic proboscis or long setae were damaged.

The toothing of the hair setae was only just visible with the oil immersion lens.

Genus **Stylaria**.**Stylaria lacustris** (L.).

Open pool in the reed-beds of the Hamun-i-Helmand, a few miles east of Lab-i-Baring, Seistan. Water very slightly brackish, fairly clear, about five feet deep; bottom muddy with a luxuriant growth of *Potamogeton pectinatus*. 8-xii-1918. N. Annandale and S. W. Kemp. Several specimens.

Fam. TUBIFICIDAE.

Genus **Branchiura**.**Branchiura sowerbyi**, Bedd.

Lucknow, Gaumati River. 15-iii-1919. G. S. Thapar. A single specimen.

The specimen was of fair size, 50 mm. in length, and is interesting from the fact that both penes are protruded. As I have previously noted (14), a penis was not described or suspected to exist in this animal, until it was found in specimens from the Inlé Lake.

I have also received, taken on the same day and from the same source, a number of specimens of a species of *Branchiodrilus*, the Naid worm with gills remarkably like those of *Branchiura*, but on the anterior part of the body instead of the posterior. The occurrence of the two together is a point of some interest. I much regret not to be able to give the specific diagnosis of the *Branchiodrilus*, of which three species are known, all Indian; but the worms came to hand when the present paper was already completed, and I fear it will be some time before I have the opportunity of undertaking detailed investigations.

Fam. MONILIGASTRIDAE.

Genus **Drawida**.**Drawida barwelli** (Bedd.) var. **impertusus**, var. nov.

Bombay, Victoria Gardens. 30-vi-1917. B. Prashad. Five specimens.

Bombay, under a tree near the Fort. 30-vi-1917. B. Prashad. Seven specimens.

Elephanta Island, Bombay; high up on a hill. 30-vi-1917. B. Prashad. Three specimens.

Elephanta Island, Bombay; in a rotten tree. 30-vi-1917. B. Prashad. A single specimen.

Elephanta Island, Bombay; on the sea-shore. 30-vi-1917. B. Prashad. A single specimen, immature.

External Characters :—The length of fair-sized specimens is from 45 to 48 mm., and their diameter 3.5 mm. The colour is a rather blotchy olive, darker on the dorsal surface than ventrally, with a still darker mid-dorsal line; the first few segments are pale. The number of segments in two specimens was 130 and 132.

The prostomium is small, prolobous, and under cover of the first segment.

Dorsal pores are absent.

The setae are small and closely paired, and are visible as far forward as the second segment. The interval *aa* is rather less than *bc* ($\frac{4}{5}$ or $\frac{5}{6}bc$), or may be fully equal to it towards the hinder end; *dd* is about $\frac{4}{7}$ of the circumference.

The nephridiopores are in a single line, just below the level of the setae *c*.

The clitellum extends over segments x-xiii (=4); it is not well defined, and the segments are largely unaltered.

The male pores are very prominent in furrow 10/11, and are situated midway between the lines of setae *b* and *c*. They are bordered by anterior and posterior lips, and it is these lips, rather than the apertures themselves, which are the conspicuous features; the extent of the lips is slightly variable,—from a point about in line with the ventral pair of setae nearly to the level of the lateral pair.

On segment x in front of the male apertures are a pair of whitish papillae with indefinite margins; the centre is whiter than the rest, and the appearance is that of some solid organ shining through. Their exact position is variable; they may even be near the middle line, internal to the line of the ventral setae.

The female pores are in groove 11/12, in line with setae *b*.

The spermathecal pores are in 7/8, immediately below the line *c*.

Internal Anatomy:—Septa 5/6 to 8/9 are moderately strengthened; the rest are thin.

There are four gizzards, in segments xiv to xvii. In the second specimen dissected, that in xvii was notably smaller than the others; and in xiii there were numerous longitudinal shining muscular bundles on the oesophagus, forming a rudimentary gizzard here also.

The last heart is in segment ix.

The testis sacs vary in shape; in the first specimen dissected they were rather kidney-shaped, with the hilus directed downwards and outwards, and the anterior ends rather narrower than the posterior; they were suspended by septum 9/10, almost by their middle, the posterior portion in x being rather larger than the anterior in ix; in the second, they were rounded smooth masses, unconstricted, mostly (practically altogether on the right side) in segment x. When opened, the contents were with difficulty evacuated, and even then only in part; a large portion of the inner surface of the sac appeared to be proliferating the sexual cells, *i.e.* the testis is diffuse; a firmer though not iridescent mass on the floor of the sac, just over the site of origin of the vas deferens, appeared to indicate the position of the funnel.

The vas deferens is either considerably or not much coiled; passing downwards from the under surface of the sac it runs part of its course in segment ix, and then enters the anterior border of the prostate in x.

The prostate is of moderate size only, flattish, sessile on the body-wall, its transverse rather greater than its longitudinal axis; its surface is quite soft and furry ("glandular").

Segment xi constitutes a perfectly closed annular ovarian chamber. The ovisacs pass backwards from the hinder wall of the chamber through segments xii and xiii, and may get into xiv; their margins may have a crenulated appearance or not.

The spermathecae are situated in segment viii. The ampulla is globular or broadly ovoid, dorsally situated in the segment, and connected by a band with the one of the other side. The duct is much convoluted as it passes down on the posterior face of septum 7/8. There is no diverticulum or atrial sac, not even in the body-wall, though the duct is slightly thickened at its termination.

Remarks:—The two species of *Drawida* to which the present specimens bear most resemblance are *D. bournei* (Mchlsn.) and *D. barwelli* (Bedd.). From the first the present form differs (besides a few minor details) in the shape of the testis sacs (not a great matter, since this is variable in these specimens), in its much smaller size, and especially in the fact that the surface of the prostates is “glandular.” From the second, it differs in a few details such as the number and situation of the gizzards (points which are however very variable), the relative magnitude of the setal intervals, and the shape of the prostates (pear-shaped in *D. barwelli*, almost circular, flat and sessile in the present form); the chief difference however is the absence of dorsal pores here,—a character which the varietal name is intended to indicate. Most of the species of *Drawida* have no dorsal pores; the type form of *D. barwelli*, however, is peculiar in possessing them. I have rejected the alliance of the present form with *D. bournei* (itself, according to Michaelsen, ⁴, a variety of *D. pellucidus*), because the smooth and shiny, or soft and furry, condition of the surface of the prostate is apparently a distinction of some importance (*cf.* Michaelsen, in the paper just quoted).

The diagnosis of the present variety may run as follows: *Drawida barwelli* var. *impertusus*:—as for the typical form, with the following exceptions. Setal interval *aa* rather less than *bc*, except at the hinder end. Male pores bounded by very prominent anterior and posterior lips; a pair of indefinite but fairly large whitish papillae on the segment in front of the male pores. No dorsal pores. Four gizzards, in xiv—xvii. Prostates flat, sessile, almost circular.

Fam. MEGASCOLECIDAE.

Subfam. MEGASCOLECINAE.

Genus **Pontodrilus**.

Elephanta Island, Bombay; on the sea-shore. 30-vi-1917. B. Prashad. A single specimen, not fully mature.

The species was presumably the one which has been found on several parts of the coast of India, *P. bermudensis*, Bedd. f. *ephippiger* (Rosa).

Genus **Megascolides**.

Megascolides prashadi, sp. nov.

Plate IX, figs. 5, 6.

Sakarwari, on the way to Mahableshtar, W. India 4-vii-1917. B. Prashad. A single specimen.

External Characters:—Length 42 mm., diameter 4 mm. The worm is unpigmented, of a buff colour, which is lighter at the ends of the body and in the clitellar region. Segments 140; the last 60 however are very short and lighter in colour, and have perhaps been regenerated.

The prostomium is prolobous.

The dorsal pores begin at the anterior border of the clitellum, in groove 12/13.

The setae are paired. In the middle of the body the relative size of the intervals may be expressed by the formula $ab = \frac{2}{7}aa = \frac{2}{5}bc = \frac{4}{5}cd$; behind the clitellum

this becomes $ab = \frac{2}{7}aa = \frac{1}{3}bc = \frac{3}{4}cd$; and in front of the clitellum $ab = \frac{2}{7}aa = \frac{2}{7}bc = \frac{3}{4}cd$. The mid-dorsal interval dd is in the middle of the body equal to about half the circumference.

The clitellum is smooth, thickened, well-defined at each end, and extends over segments xiii—xvii (= 5).

The male pores are on segment xviii, just outside the line of setae *b*. They are small, and surrounded by only a slight whitish thickening.

On segment xix is a large flat oval papilla (fig. 5); this is not quite symmetrically placed, being rather on the left side, so that while it reaches as far outwards as the male pore on the left side, it stops somewhat short of this on the right; its centre shows a transverse, almost groove-like, depression. On segment xx is a second papilla, much smaller and less definite than the last, transversely elongated, with its centre about in line with the setae *a*, extending inwards to about the middle line; like the last, it is situated on the left side.

Segment xvii is delimited in front by a groove mid-ventrally, but not elsewhere, since this segment forms part of the clitellum; on this ventral portion are seen a few small whitish circular spots, which however do not seem to have anything to do with setae. Setae *a* and *b* are absent on segments xviii and xix, and on the left side on xx.

The female pore seems to be represented by a small white dot mid-ventrally placed on xiv.

The spermathecal pores are a single pair, in groove $\frac{7}{8}$, in or immediately outside the line of setae *b*.

On the hinder border of segment viii are situated a pair of indefinite, transversely oval papillae, in position and size corresponding to the setal interval ab .

Internal Anatomy.—Septum $\frac{4}{5}$ is slightly thickened as compared with those in the middle of the body; $\frac{5}{6}$ and all the following septa down to $\frac{10}{11}$ are moderately thickened; $\frac{11}{12}$ again is only slightly strengthened.

The gizzard, in segment v, is subspherical and of moderate size. There are no calcareous glands. The intestine begins in xv, or perhaps in xvi.

The last heart is in segment xii.

Behind the clitellum the micronephridia are arranged in transverse rows of about eight to ten on each side; in the clitellar region they are also in transverse rows, and somewhat larger; in front of this they are sparser, and their arrangement is less regular. About forty segments from the hinder end the innermost nephridium on each side in each segment enlarges, and this condition is maintained to the end; there is thus a longitudinal row of larger nephridia on each side of the ventral nerve cord, but I do not think that these could be described by anyone as meganephridia, —only as enlarged micronephridia.

Testes and funnels are free in segments x and xi; the funnels were inferred from the iridescent masses which probably enclose them; the testes were separately identifiable in xi, while in x they were presumably continuous with a deeply attached mass of flocculent matter (developing sperm-morulae and spermatozoa).

Three pairs of seminal vesicles are present. The largest are those in xii, of moderate size and lobulated; in segment ix is a second pair, rather smaller and also lobulated; the third pair, in x, are smaller still, and attached to septum 10/11.

The prostates are tubular, and consist of a number of thick, adpressed opaque coils which extend through several segments. The duct is relatively short, proceeds almost straight inwards, and is narrow but broadens slightly towards its ectal end.

Ovaries and funnels have the usual situation.

The spermathecae are one pair. The ampulla is a large irregular sac, with much crenulated margins (fig. 6); the duct is about as long as the ampulla, of moderate thickness and approximately the same diameter throughout. There is a single diverticulum, originating at the ental end of the duct, lobulated, about half as long as the duct, to the side of which it is adherent.

There are no penial setae.

Genus *Perionyx*:

Perionyx sansibaricus, Mchlsn.

Plate IX, fig. 7.

Manmad, Bombay Pres. 28-vi-1917. B. Prashad. Numerous specimens.

Igatpuri, Bombay Pres. 29-vi-1917. B. Prashad. Two specimens.

Khandwa, Central Provinces. 23-vi-1917. B. Prashad. Numerous specimens.

Kala Khund, between Khandwa and Indore, Central India. 23-vi-1917. B. Prashad. Three specimens.

Baroda, W. India, on the banks of the river Vishvamitri. 9-vii-1917. B. Prashad. A single specimen.

Wathur, near Mahableshwar, W. India. 6-vii-1917. B. Prashad. Nine specimens.

Londa, ten miles from Castle Rock, Bombay Pres. 6-vii-1917. B. Prashad. Eleven specimens.

This interesting species has been previously recorded from Kodaikanal in the Palni Hills (Michaelsen, 3). From the present records it appears to be common in Western India. One of its distinguishing characters is the alternation in situation of the terminal bladders and external openings of the nephridia; these are placed at about one-third of the half circumference from the mid-dorsal line, and a similar distance from the mid-ventral line, in successive segments; as the end bladders are easily seen on opening the animal (unlike most species, where they are small or absent), the peculiarity is obvious in any dissection. The alternation is however, according to my dissections, approximate, not exact; two successive nephridia not uncommonly end at the same level on the body-wall, and once a series of four were seen to do so.

I append a few notes on the numerous specimens with which I have had to deal.

External Characters:—The purple colour of the dorsal surface extends partly on to the ventral side of the animal in the most anterior segments. I found this character of help in separating worms of this species from others when several species were mixed together in a single catch.

The dorsal pores, which Michaelsen found to begin in groove 9/10 or 8/9 in his

original single specimen, and in $4/5$ in the examples from the Palni Hills, begin here in $3/4$, remarkably far forward.

The region of the male pores is characteristic (fig. 7). Segment xviii is somewhat lengthened in the mid-ventral region, its anterior and posterior limits being bulged forwards and backwards respectively. The male apertures are small transverse slits close to the middle line; while in front and behind the pores there is a crescentic depression, the convexity of the depressions facing forwards and backwards respectively, and causing the bulging, forwards and backwards, of the intersegmental grooves; the pores are thus situated on a transverse ridge between the crescentic depressions. A characteristic feature is that the setal ring is not interrupted by the pores, but is continued across the segment, on the ridge but just behind the male pores.

Internal Anatomy:—I find the gizzard to be in segment vi (Michaelson in v); it is very rudimentary. The intestine is somewhat swollen in xiii, but not specially vascular, nor are there any ridges in the interior.

Testes and funnels are free in segments x and xi. Besides the seminal vesicles in segments xi and xii, there was in one specimen dissected a minute structure in ix, on the left side and attached to the anterior face of septum $9/10$, consisting of two small ovoid lobules, and perhaps representing a rudimentary vesicle. The vesicles in xii were larger than those in xi, and were somewhat lobulated; those in xi were markedly so.

The ampulla of the spermathecae is pear-shaped, narrowing towards the ectal end to a duct; this is short, relatively narrow, cylindrical, one-third as long and one-fourth as wide as the ampulla. There is a single diverticulum, on the inner side of the duct, consisting of a few indistinct seminal chambers aggregated together on a short stalk; the diverticulum is one-fourth the length of the ampulla.

***Perionyx millardi*, Stephenson.**

Plate IX, fig. 8.

Bombay, Malabar Hill. 1-vii-1917. B. Prashad. Three specimens.

Talegaon, on the way to Poona. 2-vii-1917. B. Prashad. A single specimen.

Kalyan, a short distance inland from Bombay, Bombay Pres. 7-vii-1917. B. Prashad. Four specimens.

Virar, N. of Bombay, Bombay Pres. 7-vii-1917. B. Prashad. A single specimen.

The present species was described by me (11) from three specimens from Malabar Hill, Bombay; these were however much softened and in bad condition, and a few supplementary notes may therefore be of interest.

The lengths of the specimens which have now come to hand show rather greater variation than those of the original batch; these are from 35 mm. (though this was perhaps regenerated at its hinder end) to 90 mm.

The ventral break in the setal rings is very small,—about $1\frac{1}{3}$ *ab*,—but it is regular from the clitellum backwards. The dorsal break is very irregular, small or absent, and often not in the middle line. The setae are slightly closer set, and certainly more

regularly placed, ventrally than dorsally. The numbers counted were:—ix/40, xii/41, xix/48, and in the middle of the body 41.

No septa are thickened.

The gizzard, in segment vi, is of some size, but its walls are thin and soft.

The seminal vesicles of segment xii are larger than those of xi, and bulge back the posterior septum of the segment; they may even extend backwards so as to bulge back septum 13/14. Both pairs are smooth and scarcely or not at all lobed.

The prostates may take up fully two segments,—xviii and xix, bulging septum 17/18 forwards and 19/20 backwards. The border of the gland is not cut up into lobes, except by an indentation on the anterior margin, and by a deep notch from which the duct emerges. The duct is quite straight, soft and only slightly shiny, and of equal diameter throughout; it passes directly inwards.

The chief difference between these specimens and those formerly described is in the spermathecae; all the specimens of the present series which were dissected possess a diverticulum, thus differing from the previous examples, in which I found none. In these, the ampulla is a large ovoid sac; the duct is much shorter than the ampulla, from which it is distinctly marked off, narrow and of the same diameter throughout. There is a single diverticulum, which varies in its appearance; regarding the specimens from Malabar Hill, Bombay (whence the original examples of the species also came), all that can be said is that there appears to be a small scale-like diverticulum from the base of the ampulla; in that from Virar the diverticulum arises from the junction of duct and ampulla, is small, rather scale-like and flattened, and lies against the base of the ampulla (fig. 8a); in that from Talegaon it is rather flat, sessile, somewhat cauliflower like, showing a number of small seminal chambers (fig. 8b). In the specimens from Kalyan the whole organ is of a rather different appearance; the ampulla is somewhat lobed, and has a fairly broad base, from which the duct issues; the diverticulum is larger than in the previous specimens, and is divided into three lobules lying side by side; indeed the incisions between the lobules appear to be so deep that each lobule has its own attachment to the upper end of the duct, *i.e.* there are really three diverticula (fig. 8c). Since however the whole of the anatomy, including the penial setae, is the same in these latter specimens as in the others, it scarcely seems allowable to separate them. The absence of any diverticulum in the original specimens is perhaps due to their relative immaturity.

Perionyx rimatus, sp. nov.

Plate IX, fig. 9.

Jor Pokhri, 4,800 ft., Sitong, Darjiling Dist., E. Himalayas. 22-28-x-1917. N. Annandale and F. Gravely. Two specimens, one mutilated.

External Characters:—Length 80 mm.; diameter 4.5 mm. Colour in the anterior part of the body a light rather blotchy purple on the dorsal side, pale in the posterior half except for a purple middorsal stripe; ventrally pale throughout.

The body is rather flattened, and the clitellum is narrowed. Segments 107.

Prostomium epilobous $\frac{1}{2}$; a faint groove delimiting the prostomium behind.

Dorsal pores from 4/5.

The setal rings are often closed both dorsally and ventrally; sometimes there is a small break, but it is irregular and varying in extent,—not more than *2ab* or *2yz*, and often less. The setae are rather small,—smaller and closer set on the ventral than on the dorsal surface. The following numbers were counted:—v/59, ix/63, xii/64, xix/56, and in the middle of the body 56.

The clitellum extends over segments xiii–xvi = 4; it is narrowed, rather lighter in colour, with visible dorsal pores and intersegmental grooves.

On segment xviii is a deep transverse crack with corrugated anterior and posterior lips, situated in the middle of the length of the segment and extending transversely over the middle half of the ventral surface. It is difficult to see the male pores in this groove, but they appear to be near its centre, and only separated by a slight median elevation in the floor of the groove.

The female area is a median whitish circular patch anteriorly on segment xiv.

The spermathecal apertures are two pairs, in grooves 6/7 and 7/8; they are small, with slightly puckered lips, rather close together, about in line with seta *c* or the space *cd*.

There are no other genital marks.

Internal Anatomy:—Septa 4/5, 5/6 and 6/7 are thin, but increase slightly in thickness progressively; 7/8 is somewhat strengthened, and 8/9 moderately so. Thence to the prostatic region all are slightly, but none much, strengthened,—10/11 is perhaps least so.

The gizzard is small and rudimentary, in segment v. The intestine begins behind the prostates.

The last heart is in segment xiii.

The nephridia end in the same line.

Testis sacs are present in segments x and xi. In x the sac is lobed, distinctly though not deeply, and presents the appearance of a number of ovoid lobes lying side by side in transverse series; it is continuous below the oesophagus from side to side, encloses both oesophagus and hearts, and appears to be divided dorsally by a median septum above the alimentary canal. In xi the sac is smaller, and lies posterior and ventrally to the vesiculae seminales.

The seminal vesicles, in segments xi and xii, have a granular surface but are not otherwise lobed. Each pair is fused dorsally over the alimentary canal, so as to form a single sac in each segment; that in xi overlies the testis sac deeper in the segment,—it is not an extension of the testis sac (as is described for *P. himalayanus* by Michaelson, 3), but has an independent attachment to the posterior face of septum 10/11. In an earlier stage of development, exemplified by the second of the two specimens, the sac of segment x is smaller, and does not include the alimentary canal and hearts; it grows up round them, it would appear, during its formation.

The prostates are large, occupying segments xviii and xix, and it may be part of xvii also; they are deeply cut up by the septa, and also otherwise much indented.

The duct is much twisted and relatively thin, not firm and shining; its ectal end is rather stouter than the rest.

There are two pairs of spermathecae (fig. 9). The organs occupy the whole available space in segments vii and viii, and meet dorsally. The ampulla is a large irregular sac, with bulgings here and there; the duct is moderately stout, half as long as the ampulla, not firm or shining. The diverticula are in the form of a few small warts on the duct a short way below the base of the ampulla; these form a cluster, about half a dozen in all, of which one appears to be larger than the rest; the smaller hardly project at all, but the iridescent spermatozoa shine through.

There are no penial setae.

Remarks:—I was at first inclined to identify this form as *Perionyx himalayanus* (Michaelsen, 3), on the ground of its possessing testis sacs,—a rather unusual feature in this genus. There is also the fact that the present specimens come from the same district (Darjiling Dist.) as *P. himalayanus*, and that both are much paler in colour than is general in this genus. But, neglecting slighter differences such as the distribution of the thickened septa, the character of the prostatic duct, the numbers of the setae, and the extent of the dorsal pores, there remain essential differences in the extent of the clitellum, the spermathecal diverticula, and especially the configuration of the male area. In *P. himalayanus* the male pores are situated on large round papillae which are quite at the sides of the ventral aspect, one-fifth of the circumference apart from each other; and a number of setae intervene between the two papillae. Here the pores are situated near each other in the depth of a transverse crack.

Though both species possess testis sacs, it is possible that their relations to the seminal vesicles are not the same. In *P. himalayanus* the sperm sacs are apparently prolonged laterally to form seminal vesicles in segments x and xi; here there is no such prolongation in segment x, seminal vesicles being absent in this segment; and the seminal vesicles of xi are independent of the testis sacs, and have their own attachment to the anterior septum of the segment.

***Perionyx pokhrianus*, sp. nov.**

Plate IX, figs. 10, 11.

Jor Pokhri, 4,800 ft., Sitong, Darjiling Dist., E. Himalayas. 22-28-x-1917. N. Annandale and F. Gravely. A single specimen (along with the last).

External Characters:—Length 65 mm.; diameter 3 mm. Colour pale violet dorsally,—posteriorly paler than in front; a mid-dorsal darker stripe; ventral surface unpigmented. Segments 96.

Prostomium epilobous $\frac{1}{2}$, the tongue (posterior portion projecting into segment i) not cut off by a groove behind.

Dorsal pores begin from groove $\frac{4}{5}$.

The setae are in rings, which are almost closed both dorsally and ventrally, and may be quite closed in the hinder part of the body; aa or $zz = 1\frac{1}{4}$ or $1\frac{1}{2}$ times ab or

yz. The setae are set slightly closer ventrally than dorsally. The following numbers were counted:—v/50, ix/58, xii/54, xix/48, and in the middle of the body 44.

The clitellum is narrowed, and extends over segments xiii-xvi (= 4). It is lighter in colour than the neighbouring segments, and the intersegmental grooves and setae are visible.

The male field occupies the middle of segment xviii. Here are seen a pair of papillae which take up the greater part of the length of the segment (fig. 10); they are bounded both in front and behind by a common transverse or slightly crescentic groove, the anterior groove being the better marked, and are separated from each other by a longitudinal groove in the middle line. On their outer margins the papillae are not delimited from the surrounding area. The male pores are near the middle line, and nearer the posterior than the anterior border of the papillae.

The female aperture is situated in a small median circular depression, close to the anterior border of segment xiv.

The spermathecal apertures are in grooves 6/7 and 7/8, very close together, nearly in line with seta *b*.

Internal Anatomy:—The first few septa (4/5-6/7) are very thin; none are missing, and none are markedly thickened, though 8/9, 9/10, 12/13, and 13/14 are slightly stronger than the others.

The gizzard, in segment v, is large and barrel-shaped; it is rather soft, but by no means vestigial. The intestine begins in xviii, but is compressed between the prostates in xviii and xix.

The last heart is in segment xiii.

The terminations of the nephridia are apparently in the same line.

Testis sacs are present in segments x and xi; both are continuous dorsally over the oesophagus and dorsal vessel. That in segment x is very delicate, and has somewhat the appearance of a seminal vesicle; that in xi, also delicate, is covered by the seminal vesicles of the segment, to which the sac is adherent, though it can be separated.

The seminal vesicles, in xi and xii, are large, and have a granular surface, but are not otherwise lobed. In xi the two vesicles are adherent in the middle line, though they are separable without damage; those in xii merely touch each other.

The prostates are large, and take up the whole of the three segments xvii-xix; they are deeply incised by the septa, and also otherwise indented. The duct is rather short, soft, irregularly twisted, and thin, but somewhat dilated at its extreme ectal end.

The female organs have the usual position.

The spermathecal ampulla is a very irregularly lobed sac (fig. 11). The duct is short,—one-fourth or one-fifth the length of the ampulla,—and marked off by a constriction at its beginning. The diverticula are small swellings, three or so in number, side by side on the upper half of the duct; they have a metallic appearance, due to the iridescent spermatozoa shining through.

There are no penial setae.

Remarks :—Here again, in the pale colour and the testis sacs, there is a resemblance to *P. himalayanus*. But here too the differences seem to be too great to allow us to unite the two forms in a single species. Apart from less important features such as the numbers of the setae and the extent of the dorsal pores, we have to consider the extent of the clitellum, the much greater development of the gizzard in the present form, and especially the quite different configuration of the male field and the much greater approximation of the pores.

var. *affinis*, var. nov.

Plate IX, figs. 12, 13.

Sitong Ridge, alt. ca. 4,700 ft., Darjiling Dist., E. Himalayas. 22-28-x-1917. N. Annandale and F. Gravely. Two specimens, one not fully mature.

Jor Pokhri, 4,800 ft., Sitong, Darjiling Dist., E. Himalayas. 22-28-x-1917. N. Annandale and F. Gravely. A single specimen.

External Characters :—Length 55 mm.; diameter 2.25 mm. A slight slaty or purplish tinge dorsally, with well-marked median darker stripe; pale ventrally. Segments 105.

Prostomium epilobous $\frac{2}{3}$, the tongue not cut off behind.

Dorsal pores begin from $\frac{4}{5}$.

The setal rings are almost unbroken both dorsally and ventrally; the ventral break is absent or practically so throughout, and there is no dorsal break in the hinder part of the body; anteriorly a small break exists on the dorsal side, where $zz = 1\frac{1}{4}yz$. The setae are closer set ventrally than dorsally. The following numbers were counted:—v/38, ix/44, xii/45, xix/37, and in the middle of the body 36.

The clitellum extends over four segments, xiii to xvi; it is narrowed, but not much modified otherwise.

The male field (fig. 12), on segment xviii, consists of a depression with sloping sides; on these sides are placed the papillae with the male pores, so that these face somewhat inwards. The papillae are rather wider transversely, are delimited by grooves in front and behind, the grooves in front being the better marked; and are separated in the middle line by a slight interval, while laterally they fade away into the general surface without any definite delimitation. The apertures are small transverse slits, their centres in line with seta *c*.

The female aperture is marked by a median roundish pit anteriorly on segment xiv, abutting on groove 13/14.

The spermathecal pores are in grooves 6/7 and 7/8, opposite the interval *cd*.

Internal Anatomy :—A number of septa in the anterior part of the body are slightly thickened, but none more than slightly.

The gizzard is in segment v, and is of moderate size and fairly firm. The intestine begins perhaps in xviii, but is narrow in xviii and xix, where it is compressed by the prostates.

The last heart is in xii.

The ducts of the nephridia appear to end at different levels on the body-wall;

but, since there are no end-bladders as in *P. sansibaricus*, it is not always easy to see where exactly they end, and in any case there is no regular alternation.

It is difficult in some of the examples of this and the last few species to demonstrate the testis sacs to complete satisfaction. Here they seem to be present in segment x, the mass of developing spermatozoa being covered over by a thin filmy membrane; the sacs of the two sides are probably continuous beneath the gut. In segment xi the testis sac is continuous on each side with the seminal vesicle.

The seminal vesicles are in segments xi and xii; they are large, taking up the whole available space, with a granular surface but not otherwise lobed; there is no indication of separation dorsally,—the pair in each segment is completely fused.

The prostates are large, and take up the whole of three segments, xvii to xix; they are deeply indented by the septa, and also otherwise much cut up. The duct is moderately long, is bent with the angle directed backwards, is soft and rather thin in its ental, thicker and shining in its ectal portion.

The female organs have the usual situation.

The spermathecae, in segments vii and viii, have each a large irregularly lobed sac-like ampulla, which is as broad as long. The duct is stout, slightly shiny, well marked off from the ampulla, about half as broad as the ampulla but considerably longer,— $1\frac{1}{2}$ times as long (fig. 13). The diverticulum appears as a rounded knob at the ental end of the duct, with two small masses of iridescent spermatozoa shining through.

There are no penial setae.

Remarks :—The above is the description of the more mature of the two specimens from Sitong Ridge. The specimen from Jor Pokhri differed slightly; thus the papillae bearing the male pores, and so the male pores themselves, were rather further apart,—opposite setae *d* instead of *c*, and separated by perhaps one-seventh of the circumference as against one-twelfth in the specimen described above; the depression containing the papillae was less marked; and the spermathecal pores were wider apart,—opposite setae *d* or *e* instead of the interval *cd*.

The closest relative of the present form is certainly the species last described. In this, the numbers of the setae are smaller, and the configuration of the male field and the degree of separation of the male and spermathecal apertures also differ. The most important points however are the spermathecae (the figures show the great difference in the relative length of the duct), and the position of the last heart (in xii here, in xiii in the last form).

It is difficult, in cases such as this, where a number of related forms have apparently arisen recently, or are possibly yet in process of differentiation, to know when the degree of differentiation which justifies the creation of a new species has been attained. Had this form been found at a distance from *P. pokhrianus*, its separation as a different species might perhaps have been justifiable; so far as the recollection of my own experience goes, the position of the last heart does not, I believe, vary within the limits of recognized species. (But see description of *Octochaetus prashadi*, *post.* p. 233).

Perionyx alatus, sp. nov.

Plate IX, figs. 14-16.

Sitong Ridge, alt. ca. 4,700, ft. ; Darjiling Dist., E. Himalayas. 22-28-x-1917. N. Annandale and F. Gravely. Three specimens.

External Characters :—Length 84 mm. ; diameter 3 mm. Colour dusky purple dorsally ; pale, slightly brownish below. Segments 123.

Prostomium epilobous $\frac{1}{3}$, tongue not closed behind.

Dorsal pores begin from groove 4/5.

The setal rings are closed dorsally and ventrally ; the setae are closer set ventrally. The following numbers were counted :—v/50, ix/55, xii/ca. 54, xix/50, and in the middle of the body ca. 52.

The clitellum extends from segment xiii as far as the anterior third of xvii ($=4\frac{1}{3}$). It is slightly lighter in colour, and is the same diameter as the rest of the body ; setae and intersegmental grooves are visible.

The male field takes up the whole of the ventral surface of segment xviii (fig. 14). Its rounded lateral borders occupy the ventro-lateral region of the segment, and its anterior and posterior borders correspond with the limits of the segment. Its chief feature is the presence of a pair of large transversely elongated papillae, conjoined by a narrow neck in the middle line, their outer ends rather narrower, and their margins crenulated. The conjoined papillae are surrounded by a deep groove or moat. The male pores appear as transverse grooves in the broader, inner part of the papillae ; the actual openings seem to be at about the middle of the grooves, the distance between them being approximately one-fourth of the transverse extent of the visible ventral surface, as seen looking down on it. The penial setae are seen as a number of black dots in the grooves.

The female aperture is represented by a mid-ventral small depression anteriorly on segment xiv.

The spermathecal pores are two pairs, in grooves 6/7 and 7/8, the same distance apart as the male pores, about in line with the setal interval *de*.

Internal Anatomy :—No septa are visible in front of 5/6, which is very thin ; none are notably thickened, though 6/7, 7/8, and 8/9 are slightly so.

The gizzard, in segment v, is large, long from front to back, cylindrical, and rather soft. The intestine begins behind the prostates, in segment xx.

The last heart is in segment xiii.

The nephridia end in the same line.

Testis sacs are present in segments x and xi. In segment xi they lie beneath the seminal vesicles, to which they are adherent, though it does not seem that their cavities are continuous ; the membrane which constitutes the sac is fine, and rather indefinite, and there is some matting together of all the structures, including the hearts, as if all were enclosed in organizing connective tissue. In segment x the condition is similar ; the testis sac is adherent to the seminal vesicle, which spreads over it from the segment behind.

The seminal vesicles belong to segments xi and xii. Those of a segment are fused together dorsally over the alimentary canal without any hint of a division; as already mentioned, the vesicle of xi extends forwards dorsally over x as well.

The prostates are large, occupying segments xvii to xix. They are cut up by the septa, and also otherwise indented into numerous lobes. The duct is irregularly twisted, soft, moderately long, and its ectal portion is wider than its commencement.

The female organs have the usual situation.

The spermathecae lie in segments vii and viii; the posterior pair are the larger. The ampulla is a considerable sac, with smooth surface, not indented. The duct is separated by a constriction, and is slightly swollen below the constriction; it is very stout,—one-third as thick as the ampulla, or even at its upper end quite half as thick: its length is about two-thirds that of the ampulla. Its swollen upper part corresponds to the diverticulum, and spermatozoa can be seen shining through in small patches, but there are no definite seminal chambers (fig. 15).

The penial setae (fig. 16) are 1.08 mm. in length, and 20. in thickness. The shaft is almost straight for the greater part of its length, but has a sharp curve at its proximal end, resembling that of a hockey stick, and is more gently curved towards the tip. The point is blunt; and the ornamentation consists of irregularly scattered minute spines on the distal portion of the shaft.

Remarks :—This species belongs to the same group as the preceding (presence of testis sacs, and character of the spermathecal diverticula). It is however well differentiated by the presence of penial setae, and the characteristic conformation of the male genital field; the specific name refers to the large wing-like papillae of this region.

***Perionyx shillongensis*, sp. nov.**

Plate IX, fig. 17.

Shillong, Assam; 4,500–5,000 ft. 16–20-iv-1918. N. Annandale. Two specimens

External Characters :—Length 66 mm.; diameter 3 mm. Colour a dusky purple dorsally, passing through violet to the pale unpigmented ventral surface. Segments 120. The animal is circular in transverse section (the species of the genus are usually more or less flattened dorso-ventrally).

Prostomium epilobous $\frac{1}{2}$, tongue not cut off behind.

Dorsal pores begin from groove $\frac{3}{4}$.

The setal rings present a very small and rather irregular dorsal break ($zz = 1\frac{1}{4}yz$), absent altogether in the hinder part of the body; and a small ventral break ($1\frac{1}{4}ab$), more regular than the dorsal but absent in the posterior third. The setae are rather more closely set ventrally. The following numbers were counted :—v/42, ix/46, xii/49, xix/48, and in the middle of the body 48.

The clitellum extends over five segments, xiii to xvii; it is very slightly swollen, and there is a slight difference in tint, but this region is otherwise unaltered.

The male field is a white, rather swollen, transversely elongated oval area on the ventral surface of segment xviii, about two and a half times as broad as long, and

taking up the length of the segment. The pores are fairly conspicuous, rather close together, about in line with the setal interval *cd*.

The female pore is apparently situated in a small whitish area anteriorly on segment xiv.

The spermathecal apertures are situated in grooves 7/8 and 8/9, about the same distance apart as the male pores or slightly closer, in line with the interval *bc*.

Internal Anatomy :—The septa of the anterior part of the body as far back as the prostatic region are slightly thickened, with the exception of the first, 4/5, which is very thin; perhaps 6/7–9/10 are most thickened.

The gizzard, in segment vi, is of fair size; the walls are somewhat, but not very, soft, and it must be reckoned as well developed for a species of this genus.

The intestine begins in segment xvi; no calciferous glands were seen.

The last heart is in segment xii.

The ducts of the nephridia end in approximately the same line.

Testes and large funnels are free in segments x and xi.

The seminal vesicles are in xi and xii; they are large, and bulge out the segments in which they are contained, those in xii pressing back septum 12/13 to the level of 13/14. They are smooth and not cut up into lobes. Those in xii meet dorsally but do not fuse; those in xi actually fuse in the posterior part of the segment.

The prostates are of moderate size, and are confined to segment xviii, though bulging the septa forwards and backwards to some extent. The surface is indented so as to form a number of lobes. The duct comes off from a hilus on the inner side, is short and straight, and though moderately stout is soft and without muscular glitter.

The ovaries and funnels are in segment xiii. Tiny white subspherical appendages by the side of the alimentary canal on the anterior wall of segment xiv appear to be ovisacs.

The spermathecae, in segments viii and ix, are large, and fill out their respective segments. The ampulla is an ovoid sac. The duct is half as long and almost half as thick as the ampulla,—that is, relatively very stout. The diverticula are present as two clusters of seminal chambers on the duct just below the base of the ampulla; each cluster is cauliflower-like, and sessile by a broad base; the clusters leave the postero-internal and anterior or antero-internal aspects of the duct free (fig. 17).

The penial setae are .87 mm. long, and 20μ thick. The shaft is straight, the tip slightly bowed and bluntly pointed. The ornamentation consists of about eight rings of rather fine spines; there may be a very fine ninth or even tenth ring.

Perionyx fossus, sp. nov.

Plate IX, fig. 18, 19.

Shillong, Assam; 4,500–5,000 ft. 16–20-iv-1918. N. Annandale. A single specimen.

External Characters :—Length 86 mm.; diameter 3.5 mm. Colour a dusky purple dorsally, pale and unpigmented ventrally, the upper tint shading off rather gradually into the lower. Segments 136. The body here again is circular in transverse section.

Prostomium epilobous $\frac{3}{4}$, tongue cut off behind.

Dorsal pores begin from groove $4/5$.

The setal rings are interrupted dorsally ; $zz = 2yz$ behind the genital region, but is rather less elsewhere,—in general about $1\frac{1}{2}yz$; the interval is regular, and the setae z are in longitudinal lines. There is no ventral break. The ventral setae are much closer set than the dorsal. The following numbers were counted :—v/52, ix/56, xii/56, xix/52, and in the middle of the body 54.

The clitellum extends over half of segment xiii in front and one-third of xvii behind ($=3\frac{5}{6}$). It is smooth, rather lighter in colour, and retains both the setae and intersegmental grooves.

The male field is a deep squarish depression midventrally on xviii, which takes up the whole length of the segment, and is about one-third of the ventral surface in transverse extent. The anterior wall of the depression is vertical, the posterior slopes more gently ; the sides are steeper than the posterior, but not so steep as the anterior wall. Across the floor and sides of the excavation extends a transverse groove—very narrow, a crack only. The male apertures appear to be situated in this crack, at the junction of the floor and side walls of the depression ; they are thus fairly close together, and about in line with seta d or e .

The female pore is indicated by a slight depression in a rather pale circular area, between the setal zone and anterior margin of segment xiv.

The spermathecal pores are two pairs, in grooves $7/8$ and $8/9$, fairly wide apart,—separated by about a quarter of the circumference, or in line with about the ninth seta from the middle line.

Internal Anatomy :—No septa are notably thickened ; perhaps $9/10$ is most so. The first is $4/5$.

There is a rather large but soft gizzard in segment vi. There are no calcareous glands, but the oesophagus shows the traces of transverse vascular channels in segment xiii, though the tube is not wider here than in neighbouring segments. The intestine begins in xvii.

The last heart is in segment xiii.

The nephridial ducts end in the same line.

Testes and funnels are free in segments x and xi.

The seminal vesicles in segment xi are quite fused together dorsally, and fill out the whole of the segment. Those which belong to segment xii are similarly fused,—in their hinder parts at any rate ; they pass beyond the limits of segment xii and form a large mass which extends to the hinder end of xiii.

The prostates are large compact masses, which bulge the septa of segment xviii forwards and backwards, and in this way take up a space of three or four segments. The gland is but little cut up into lobes. The duct emerges from a deep cleft on the inner surface ; it is narrow and bent once or twice while still within this cleft, broadens on emerging, and becomes fairly stout and shining in its ectal portion.

The spermathecae fill out all available space in segments viii and ix. The ampulla is irregularly ovoid in shape, and the duct is half as long and quite one-third as

thick as the ampulla. The diverticula are rather inconspicuous; they are small flattish swellings on the duct at about the middle of its length, two in number, sessile, and lobulated (fig. 18).

The penial setae (fig. 19) are very little modified. In length they are .45 mm., in thickness 18μ ; their shape is that of an ordinary seta, with the usual double curve. The tip is fairly sharply pointed, and there is no nodulus. The margin shows a few small indentations near the tip.

Perionyx turaensis, sp. nov.

Plate X, figs. 20, 21.

Above Tura, Garo Hills, Assam; 3,500–3,900 ft.; under bark. July–August 1917. S. Kemp.
Five specimens and two fragments.

External Characters:—Length variable, but the differences are probably due to fragmentation. The animal seems to break up easily; one specimen shows a regenerated zone at the hinder end. The longest specimen, apparently complete, measured 74 mm.; diameter 2 mm. Colour dark brownish purple dorsally, with still darker median stripe; ventral surface unpigmented. Segments 132. The ventral surface is somewhat flattened.

Prostomium epilobous $\frac{1}{2}$ or rather more, with squarish posterior tongue, which may or may not be demarcated behind.

Dorsal pores from groove $4/5$ or $5/6$.

The setal rings are almost closed ventrally; on the dorsal side zz may be twice yz in front of the clitellum, but is less behind. The setae are closer set ventrally, and the ventral setae appear smaller than those on the dorsal side. The numbers are difficult to count, and there are intervals where some seem to have dropped out, so that the following are estimates only:—v/48, ix/56, xii/54, xix/44, and in the middle of the body 55.

The clitellum is rather narrowed; it includes two-thirds of segment xiii and extends back to the hinder border of xvii ($=4\frac{2}{3}$). The intersegmental furrows are not obliterated.

The male pores are on xviii, close together near the middle line, on small round papillae. The papillae touch each other or almost so, and are situated in a slight common depression, rectangular or transversely oval in shape, which does not take up the whole length of the segment.

The female pore is single, and appears as a simple depression or as a transverse slit in front of the setal zone of segment xiv.

The spermathecal apertures are two pairs, in grooves $7/8$ and $8/9$, close together near the middle line.

Internal Anatomy:—No septa are specially thickened, though $8/9$ and in an even less degree $7/8$ are slightly so.

The gizzard, in segment vi, is rudimentary.

A pair of calcareous glands are present in segment xiii as well-defined ovoid swellings in which the vascular channels run longitudinally. The intestine begins in xviii.

The last heart is in segment xii.

The arrangement of the anterior male organs was not quite clear. There are seminal vesicles in segments xi and xii,—large square masses filling out the segment, attached to the anterior septum of the segment, those of xi perhaps partly fused together in the middle line, those in xii contiguous only. In x there is a similar structure; in the specimen first dissected it was definitely noted to be a sac, not merely a compact mass of coagulum; the funnels appeared to be contained within them, so that they would be testis sacs. In another specimen (in which however, as noted below, the male organs had an abnormal position) there were no sacs in the corresponding segment,—only a cleanly detachable mass of coagulum; and the funnels were free in this and the next segment.

The prostates are compact cubical masses in segment xviii, the septa of which are not bulged backwards or forwards. The short and moderately stout duct passes transversely inwards from the hilus.

The ampullae of the spermathecae have a peculiar shape; the anterior border is deeply indented, so as to form two or three rounded lobules (fig. 20), the lowest of which may simulate a diverticulum. The duct is thick, short, and not definitely marked off from the ampulla. What I take to be the real diverticula are a few small rounded knobs at the ental end of the duct, which apparently are not always present.

The penial setae (fig. 21) are .5 mm. long, and 11 μ thick at the middle. The shaft is straight with a slight curvature at the distal end, and tapers rather rapidly. The tip however is cut off squarely, and carries five or six fine spines. There are also six circles of fine spines on the curved distal portion of the shaft, just above the tip.

The abnormal specimen mentioned above had the genital organs two segments further forwards than the normal. Thus the male pores were on xvi, the posterior seminal vesicles in x (extending back however as far as xii), the anterior vesicles in ix, the spermathecae in vi and vii. The male funnels were free in segments viii and ix.

Remarks :—The nearest relative of the present species is *P. parvulus* (Stephenson, 12), from near Ghoom in the E. Himalayas; but the penial setae and form of the spermathecae prevent the union of the two. These two, with *P. excavatus*, *P. fulvus*, and perhaps *P. bainii*, seem to form a closely allied natural group.

***Perionyx pullus*, sp. nov.**

Plate X, fig. 22.

Belgaum, Bombay Pres. 4-vi-1917. T. R. Bell. A single specimen, the posterior end broken off.

External Characters :—Length of the fragment 62 mm.; diameter max. 3.5 mm. Colour dark grey on both surfaces, scarcely any difference between dorsal and ventral. Segments present 165. Ventral surface concave except at anterior end, thus presenting a longitudinal groove bordered by prominent ventro-lateral ridges.

Prostomium epilobous $\frac{3}{4}$, the tongue being triangular; from its backwardly directed point a groove is continued in the middle line back to the clitellum.

Dorsal pores begin in groove 1/2; this must be about the extreme anterior limit which they ever attain, though I could not say that it is unique. Beddard (1) states that dorsal pores are never found on the first one or two segments of the body.

The setal rings are interrupted dorsally; in front of the clitellum $zz=3yz$, and behind=about $2yz$; but behind the clitellum the interval itself, as well as the inter-setal intervals on each side, is irregular. The ventral break is absent, or small and irregular. On the ventral surface the setae are small and very close together,—almost as close as they can be. For this reason, and also because of the dark colour of the animal, they are very difficult to count; behind the clitellum there are about 60, and further back 64.

The clitellum is extensive, from xi to xx (=10); it is slightly swollen, less marked or absent ventrally, rather darker in colour, and dorsal pores are absent.

The male field is situated on segment xix (whether normally, or exceptionally in this particular specimen, cannot be said). It consists of a mid-ventral rectangular area, rather broader than long, which takes up most of the length of the segment; it is delimited at the sides by slight grooves and in front and behind by deep trenches, which coincide with the intersegmental furrows; the trenches are however much broader than the intersegmental furrows, and encroach anteriorly and posteriorly on the surface of the segment. The pores are apparently on two small whitish papillae very close together near the midventral line.

The female pore was not visible.

The spermathecal apertures are two pairs, in grooves 7/8 and 8/9, close to the middle line.

Internal Anatomy:—No septa are specially thickened.

There is no gizzard, even vestigial. The pharyngeal glands are especially bulky, and extend as large masses on the alimentary canal backwards to segment ix. The oesophagus is bulged laterally, and its walls are vascular, in segments x-xiii. The intestine begins in xvii.

The last heart is in segment xii.

The nephridia end in approximately the same line.

The male funnels (presumably testes also) are free in segments x and xi.

Seminal vesicles occupy segments xi, xii, and xiii. They are relatively small, are attached to the anterior wall of their segment in each case, and have a racemose appearance owing to their being composed of a number of small lobules; indeed the extremely racemose appearance of those in segment xiii caused them momentarily to be mistaken for ovaries. There appeared to be an additional minute pair of racemose vesicles in xiv also.

The prostates, in segment xix, are small, and consist of a number of elongated finger-like lobes, the whole forming a bushy cluster. The duct is small, soft, not much thickened, and runs transversely inwards.

Ovarian funnels were identified in xiii.

The spermathecae (fig. 22) are situated in segments viii and ix. The ampulla is

very irregular in shape, and narrows below to become the duct without any distinct delimitation. If the beginning of the duct is taken to be just below the diverticula, it is about as long as the ampulla; it narrows gradually towards its ectal end. The diverticula, about three in number, are small rounded sessile chambers, situated at what may be considered as the lower part of the ampulla.

There are no penial setae.

Perionyx minimus, sp. nov.

Plate X, fig. 23.

Belgaum, Bombay Pres. 4-vi-1917. T. R. Bell. Numerous specimens.

External Characters.—The worms are very small; a long one measures 45 mm. in length, while the thickness is only 1 mm., or as a maximum $1\frac{1}{4}$ mm. The colour is a medium brown dorsally, and a rather lighter brown ventrally. Segments 100. The ventral surface is flattened.

Prostomium epilobous $\frac{1}{2}$ or nearly so, tongue cut off behind; both prostomium and first segment divided in the mid-dorsal line by a longitudinal groove.

Dorsal pores from $4/5$; or a rudimentary pore in $4/5$, and the first well developed pore in $5/6$.

The setal rings are almost closed ventrally; the dorsal interval is well marked, $=2yz$. The setae are much closer set ventrally than dorsally. On the twentieth segment there are about 26 setae, in the middle of the body about 36.

The clitellum extends from the middle, or perhaps the anterior end, of xiii backwards to include segment xvii ($=4\frac{1}{2}$ or 5); it is rather narrowed, of a somewhat darker colour, and the separate segments are easily distinguishable.

The male pores are on conspicuous round papillae on xviii. The area between these papillae is depressed, the depression extending longitudinally from the middle of xvii to the anterior third of xix; this area is encroached on laterally by the papillae, so that the depression has a dumbbell shape, the dumbbell being placed longitudinally; the apertures look somewhat inwards.

The female pore (or pores) are situated in a transverse groove anteriorly on segment xiv.

The spermathecal pores were not distinctly seen, but appeared to be about a quarter of the circumference apart, in grooves $7/8$ and $8/9$.

Internal Anatomy.—No septa are thickened.

There is apparently a rudimentary gizzard in segment v. The oesophagus is slightly bulged in segments xiii and xiv, with longitudinal vascular striations. The intestine begins behind the prostates, in segment xix. The "pharyngeal glands" extend back to segment vii as definite lobes on each side filling out the segments.

The last heart is in segment xii.

Relatively large seminal funnels are present in segments x and xi, embedded in a mass of very adherent flocculent matter simulating seminal vesicles; the testes were not separately identified.

Seminal vesicles are present in segments ix and xii; both pairs are brown in

colour. Those in xii are large and lobulated, and meet but do not fuse with each other dorsally; the vesicle on the right side in segment ix was moderately large, but that on the left was small (? had been in part detached and washed away).

The prostates occupy more than one segment,—xviii and part of xvii on the right side, xviii and part of xix on the left; they are somewhat loosely lobulated. The duct is short, narrow and rather soft; it is covered over by the lobules of the gland, and is not visible till these are separated.

The ovaries, relatively very large, and funnels are in segment xiii. In segment xiv are conspicuous ovisacs, containing large ova.

The spermathecae are of moderate size, in segments viii and ix. The ampulla is rounded, and rather flattened between successive septa. The duct is of about the same length as the ampulla; at its ental end, between the two diverticula, it is rather narrow, but becomes thicker below them (fig. 23). The diverticula are small, subspherical, and attached to the ental end of the duct by short stalks; they have rather a cauliflower-like appearance, but this is not due to any lobulation,—it seems to be occasioned by wisps of iridescent spermatozoa shining through the wall.

There are no penial setae.

***Perionyx igatpuriensis*, sp. nov.**

Plate X, fig. 24.

Igatpuri, Bombay Pres. 29-vi-1917. B. Prashad. Three specimens, one consisting of only the anterior end.

Elephanta Island, Bombay; on the sea-shore. 30-vi-1917. B. Prashad. Three specimens.

External Characters.—Length 40–52 mm.; diameter 2.2–2.5 mm. Colour dark, purple dorsally, pale ventrally; clitellum slightly lighter dorsally than the rest of the dorsal surface. Segments 150–170.

Prostomium epilobous $\frac{1}{2}$, tongue broad, cut off behind.

Dorsal pores begin from groove 4/5.

The setal rings are unbroken dorsally; the ventral break is small and irregular, or altogether absent. The setae are closer set ventrally than dorsally. The following numbers were counted:—v/36, ix/48, xii/46, xix/41, and in the middle of the body 44 (in the specimen examined from the Bombay material the numbers were somewhat greater in the anterior segments).

The clitellum extends over xiii–xvii (only to xvi in Bombay specimen) (=4 or 5); setae are present, and the intersegmental grooves can be distinguished.

The male pores appear as depressions, each in the middle of a small circular area with slightly raised lips, near the middle line in segment xviii; these areas are separated only by a groove in the mid-ventral line, and in length take up nearly the whole segment. Black dots, which may be seen in the depressions, are the penial setae.

The female pore is represented by a whitish dot in a transversely oval depression anteriorly on segment xiv.

The spermathecal pores are two pairs, in grooves 7/8 and 8/9; they are conspicu-

ous round apertures near the middle line, the same distance apart as the male pores.

Internal Anatomy :—The first septum appears to be $5/6$; all are present, and all are thin.

The gizzard, in segment vi, was soft and rather small in the original specimen from Igatpuri; in the specimen from Bombay however it was of large size, but soft and yielding easily to pressure with a needle ; in shape it was rather cylindrical, but somewhat narrower posteriorly.

There are no calciferous glands ; the gut may be bulged laterally in segments xiii and xiv. The intestine begins in xxiii.

The last heart is in xiii.

The endings of the nephridia are in the same line.

Testes and funnels are free in segments x and xi ; these segments are full of flocculent material (developing spermatozoa).

Seminal vesicles occupy segments xi and xii ; they are large paired sacs, not fused in the middle line. They are rounded in form, their borders not indented or lobed (in the Bombay specimen they appeared somewhat granular, as if made up of minute lobules). Those in xii are the larger, pressing back septum 12/13.

The prostates are compact masses occupying segment xviii, the limiting septa of which are much bulged apart by their bulk ; each consists of an anterior and posterior lobe, from between which the duct issues. The duct is short, straight, and narrow, and passes transversely inwards.

The large ovaries and the funnels are in segment xiii.

The spermathecae, in segments viii and ix, present an elongated ovoid or irregular ampulla with a short stout duct, a third or a quarter as long and a third as wide as the ampulla. There is a single diverticulum, attached to the base of the ampulla, sessile, cauliflower-like and consisting of a number of small seminal chambers ; in extent it is one-third or a quarter as long as the ampulla, against the lower part of which it may be flattened (fig. 24).

The penial setae are .44-.52 mm. long, and 15μ thick in the middle. The shaft is almost straight, very slightly bowed,—more so at the distal end ; the tip is simply and rather bluntly pointed ; there are about six rings of rather small spines near the tip. (In the Bombay specimen the setae were a little larger,—.68 mm. long, and 20μ thick, with seven well-marked rings of small spines, and two or three rings only very faintly indicated proximal to these).

Remarks :—The present species resembles *P. millardi*,—very closely in many respects. The distinctive difference is in the spermathecae, which there have no diverticulum. Minor differences are the setal rings,—the breaks dorsally and ventrally being smaller or mostly absent here ; and perhaps the penial setae, which have fewer rings of spines in the present species.

Perionyx spp.

In the various collections examined there were a number of specimens of this genus which could not be referred to any species on account of immaturity. Some

such were obtained from above Tura, in Assam; from the Western Ghats; from Pashok in the Darjiling District; from the Sitong Ridge, and from hill streams near Sitong, also in the Darjiling District. All these regions are already in the recognized area of distribution of the genus, and the specimens may be dismissed with a couple of remarks on their habits. Of a batch of specimens found above Tura, Mr. Kemp remarks, "This worm is found coiled up on the upper or under sides of leaves in dense jungle, forming a compact gelatinous mass. When touched it springs to life, performing somersaults and other acrobatic feats." The second noteworthy feature is the aquatic habitat of the worms from hill streams near Sitong; they were found living in water under stones.

Genus **L a m p i t o**.

Lampito mauritii, Kinb.

This worm is one of the commonest in India,—absolutely the commonest in the present collections; and being so widely distributed it is scarcely necessary for the future to note the precise details of each capture.

The following are the localities from which I have received it:—In the Central Provinces and Central India, from Nemar Kheri on the way to Indore, Katni, Gwalior and Jubbulpore; in S. Rajputana, from Dungarpur and Banswara; and in the Bombay Presidency from Bombay (where it is very common), Broach, Surat, Ahmedabad, Nadiad, Dhanu, Sirvai Madhopur, Baroda, Palchar, and Joshachivir on the way to Mahableshtar.

Genus **P h e r e t i m a**.

Pheretima posthuma (L. Vaill.).

Also extremely common; from Khulna and Dattapukur in Bengal; Udaipur in Rajputana; Gwalior in Central India; Bindra Ban, near Muttra, United Provinces; and Baroda in the Bombay Presidency.

Pheretima hawayana (Rosa).

A common Indian worm; from Bindra Ban, Udaipur, and Bombay.

Pheretima heterochaeta (Mchlsn.).

Common in India; from Sureil, 5,000 ft. in Darjiling District. An immature specimen, probably of this species, from Pashok, 3,500 ft., also in Darjiling District.

Pheretima elongata (E. Perrier).

Manmad, Bombay Pres. 28-vi-1917. B. Prashad. Several specimens.

Palia, between Indore and Ujjain, Central India. 27-vi-1917. B. Prashad. One specimen, a mutilated anterior end.

Indore, Central India. 23-vi-1917. B. Prashad. Three specimens.

Indore, banks of River Kan. 25-vi-1917. B. Prashad. Several specimens, immature, but probably of this species.

Ujjain, Central India. 26-vi-1917. B. Prashad. Several specimens, with others, probably of the same species, but immature.

Namkana, Sunderbans, Bengal; near the banks of a reclaimed island. 10-xi-1918. B. Prashad. Several specimens.

Calcutta. Nov. 1913. E. C. Dormieux. A single specimen.

The length of the specimens from Manmad (the only ones subjected to a complete examination) varied; a long one was as much as 230 mm.

Large testis sacs, enclosing alimentary canal, hearts, and dorsal vessel, as well as the testes and funnels, were present in segments x and xi; and seminal vesicles in xi, xii and xiii, as noted by previous observers. The seminal vesicles of xi are contained within the testis sac of that segment; those of xii are large, and meet mid-dorsally; those of xiii are small and rounded.

It may be noted that the last heart was in segment xii, in the specimen dissected. I found no spermathecae (this condition has previously been noted in the species).

Remarks:—This worm has not hitherto passed for common in India. It was recorded from three localities by Michaelsen (3) as a result of his examination of the extensive collection of the Indian Museum,—from Hyderabad, Deccan; Kandy in Ceylon; and Karachi in Sind. I had not myself met with it previously. Like others of the genus, the present species has a wide distribution outside India—indeed it might be called a “world-wanderer.”

The worm has generally gone under the name of *P. biserialis*; Michaelsen was able, by an examination of the types of *P. elongata*, to establish its identity with the latter (4).

***Pheretima lignicola*, Stephenson.**

Bombay. June, 1915. N. B. Kinnear. Several specimens, not all mature.

Bombay. 7-xi-1914. N. B. Kinnear. A number of specimens.

The colour appears to be variable; olive-green and brown have been noted in previous-specimens; these,—the first of the two batches at least,—were a metallic bluish purple dorsally, and pinkish ventrally.

The setae of segments ii-ix were larger than those on the rest of the body. The intestinal caeca were crenulated on their dorsal margin.

Subfam. *OCTOCHAETINAE*.

Genus- ***Hoplochaetella***.

***Hoplochaetella anomala*, sp. nov.**

Plate X, figs. 25-29.

Belgaum, Bombay Pres. 5-vi-1910. N. B. Kinnear. Eight specimens, and a fragment consisting of the posterior end. In bad condition.

External Characters:—Length about 85 mm.; diameter 3 mm. The worms are apparently unpigmented or almost so; in their present condition, with much thinned body-walls, the colour is given by the intestinal contents. Segments ca. 105.

Prostomium epilobous $\frac{1}{3}$, tongue broad, sides slightly converging behind, not cut off by a transverse furrow.

Dorsal pores begin from 4/5.

The setal rings are almost closed ventrally; $aa = 1\frac{1}{2}ab$. The dorsal break is about 4yz in front of the clitellum, 3yz behind it, and 2yz in the middle of the body. The setal intervals decrease somewhat outwards from the middle line, so that $aa > ab > bc > cd$. The numbers of setae are difficult to ascertain, since the worms will bear scarcely any manipulation, and doubtless many setae have dropped out; I could only count the intervals between the muscle bundles:—viii/36–44, xii/40–46, and in the middle of the body 40.

The clitellum extends from $\frac{1}{2}$ xiii to $\frac{1}{2}$ xvi (=3); it is smooth, brownish, swollen and well defined; setae are present, but no intersegmental furrows.

The male area (fig. 25) presents two pairs of well-marked depressions, crater-like, with thickened and rounded margins, on segments xvii and xix; these are rather oval in a transverse direction. The lip is less definite on the inner side, where it merges into a mid-ventral thickened area between the two depressions of a pair. The depressions extend transversely between the lines of setae *b* and *h*, and with their lips and the median thickened area take up the whole transverse extent of the ventral surface; longitudinally also they occupy the whole of the length of their respective segments, without however encroaching on segment xviii.

The male apertures are in the inner portions of the excavations, between the lines of setae *c* and *d*.

The female aperture is single, in a small circular whitish area just in front of the setal zone of segment xiv.

The spermathecal apertures are two pairs, on small papillae on segments viii and ix; they are in line with seta *c*, and about one-fifth of the circumference apart. In segment ix the papillae are in the setal zone, in viii in front of it.

The above description is that of the specimen of which a complete examination, internal and external, was made. In some of the other specimens there were a few variations in the external genital marks which deserve mention.

In one, there was a cup-shaped shallow depression, also with a thickened rounded margin, on the left side of segment xviii; this was rather smaller than those on xvii and xix, much shallower, and slightly internal in position to them. In another, there were depressions on both sides of xviii. Or the depressions containing the male pores may be smaller than above described, and circular in shape, not extending so far outwards; or the depressions may be reduced by the filling up of their outer part, the lip being much thickened here, almost like a papilla to the outer side of the pit.

A displacement of the setal line in the spermathecal region has been noticed in other species of the genus. This was not the case in the specimen first examined, though setae *cde* appeared to be absent on both sides of segments viii and ix. In another, *cdef* were displaced forwards on both sides in segment viii; *cd* were displaced backwards on the right side in ix, while on the left side the setal line was irregular.

Internal Anatomy:—The septa were all softened; they are apparently distinguishable as far forwards as 3/4, and 11/12 and 12/13 are perhaps somewhat thickened.

The gizzard is of large size, regularly ovoid, firm, in segment vii. The calcifer-

ous glands are in segments x-xiii, small, ovoid, set off from the alimentary canal; in segments x and xi they are within the testis sacs. The intestine begins in xvi.

The last heart is in segment xii. There is no large transverse vessel in xiii, but anteriorly in xiv a pair of stout vessels are given off from the dorsal vessel,—these may however only go to the alimentary canal.

In the first nineteen segments only micronephridia are present; some of these are scattered, and others form large tufts anteriorly by the side of the pharynx. Meganephridia begin from segment xx; probably micronephridia coexist, but have become unrecognizable.

Testis sacs are present in segments x and xi as large chambers which enclose the dorsal vessel and alimentary canal as well as the testes and funnels; those of segment x enclose in addition a pair of seminal vesicles.

The seminal vesicles are in segments ix, x, and xii; those in x, within the testis sacs, are attached to the posterior wall of the segment; those in ix and xii are large, and only slightly indented into lobes.

The prostates are two pairs of coiled tubes. The anterior occupy segments xvii and xviii, the posterior segments xix to xxi. The duct is in each case stouter than the gland, shining, straight and rather short, thinner at its ental end; each passes obliquely forwards and inwards. The ends of both pairs of ducts are surrounded by a soft white cushion on the inner face of the body-wall.

The vasa deferentia are two on each side, and pass backwards side by side beyond the termination of the anterior prostatic duct (fig. 26); shortly behind this, the outer duct of the two doubles back, after crossing underneath the inner, and ends immediately behind the termination of the anterior prostatic duct; the other vas deferens goes on, and ends immediately in front of the termination of the posterior prostatic duct.

The ovaries are in segment xiii; there are small ovisacs in xiv.

There are two pairs of spermathecae; the ampulla is a sac of very irregular form (fig. 27),—in some cases a portion is almost constricted off. The duct is stout, nearly as long as the ampulla, dilated and not shiny in its ental part, narrower and shining below; at its thickest part it is half as broad as the ampulla; it is separated from the sac above it by a constriction. The diverticula are two, opposite each other, attached to the duct immediately below the dilated part; each consists of a few rounded seminal chambers, the whole being sessile on the duct. The endings of the ducts, as seen on the inner side of the body-wall, correspond in position to the papillae seen externally.

As in other species, there are a number of accessory glands. These are clusters of finger-shaped structures, three to five in each cluster, of various lengths, the longest about equal to the duct of the spermatheca or rather longer. Each cluster ends near the termination of a spermathecal duct. The accessory glands themselves are solid, but have a distinct and fairly long duct with a lumen, and they are connected, where they pierce the body-wall, with the modified copulatory setae of segments viii and ix; fig. 28 is a rough sketch of gland and seta extracted together.

These copulatory setae are in length .61 mm., and in thickness at the middle 22μ ; they are almost straight, with a slight curve at the proximal end, tapering and bluntly pointed distally. There is scarcely any ornamentation,—only a few very fine oblique lines, or semicircular markings convex proximally, near the tip (fig. 29).

There are no penial setae in the segments of the male apertures.

Remarks:—The above interesting form has obvious relations with those I have previously described (13) under the name *Hoplochaetella*; it has, besides the same arrangement of prostates and spermathecae, the same displaced and modified setae in the neighbourhood of the spermathecal apertures, the same distribution of calciferous glands, and the same peculiar nephridial system. It does not however agree in all points with the emended definition of the genus which I gave.

Of the points of difference, one of the most interesting is the manner of ending of the vasa deferentia; in the other species of the genus the vasa deferentia unite, and then open in common with the anterior prostate on the seventeenth segment, while here the vasa are separate, and open, one with the anterior prostate on segment xvii, and the other with the posterior on xix.

In the Megascolecidae, what may be described as an attraction between the terminal portions of the genital organs is of very general occurrence. The primitive condition in the family is that known as the "original Acanthodriline," where the prostates end on segments xvii and xix, the vasa deferentia (after joining together) on xviii, and the spermathecae in furrows 7/8 and 8/9. In the Megascolecinae, one pair of prostates has disappeared, and the other has been "attracted" to join the termination of the vasa deferentia in xviii, an intermediate stage being seen in the genus *Diplotrema*. In the other species of *Hoplochaetella*, and in *Erythraeodrilus*, the conjoined vasa deferentia have been attracted forwards (to continue the same figure) to join the anterior prostatic duct on xvii. In the other species of *Hoplochaetella* also, the two pairs of prostates are approaching each other, and the two pairs of spermathecae show the same tendency. The very frequent union of the original pair of female pores on segment xiv is perhaps to be referred to the same group of phenomena. In *Eutyphoeus* (Octochaetinae) the single vas deferens on each side ends in common with the prostatic duct on xvii. Similar instances can be quoted from the Ocnerodrilinae.

In the present form, the attraction has taken a different course; the two vasa deferentia of each side have been as it were pulled apart, one towards the anterior, the other towards the posterior prostate, while these maintain their original position on the middle of segments xvii and xix.

In regard to the above point of difference, neither the present nor the former species of *Hoplochaetella* can be said to be primitive as compared with the other; evolution has merely taken a different course in the two. In certain features however the present form appears to show a more primitive condition than the species previously described. Thus the two pairs of spermathecal apertures, which in the other species are both on segment viii, are here more widely separated, on segments

viii and ix respectively. So too the prostatic apertures are in previous species posteriorly on xvii and anteriorly on xix, or actually in the furrows 17/18 and 18/19; while here they maintain their original position at the middle of xvii and xix.

Lastly, the testes and funnels are free in segments x and xi in the former species but are contained in testis sacs in the present form. Here I am not clear as to which is the more primitive condition. As a rule, of course, the free condition is to be looked on as primitive, and that in which the testes and funnels are enclosed in sacs, —separated-off portions of the coelom,—as secondary. But in the previous species of the genus the testes and funnels are not free in the usual sense; segments x and xi are very narrow, and septa 9/10, 10/11, and 11/12 are fused together at their periphery so as, at first, to give the impression of one enormously thickened septum. What has happened is that these septa have become approximated, and the contained segments very much contracted; whether originally, before the contraction took place, they contained testis sacs cannot now be decided,—the sac-walls (if the sac originally, as in the present form and often elsewhere, contained alimentary canal, hearts and dorsal vessel) may have simply fused with the walls of the segment.

I have previously (13) shown that *Hoplochaetella* is to be regarded as the ancestor of *Erythraeodrilus*. In some ways the present form may represent that ancestor more closely than any of the previous species; thus the condition as regards testis sacs is the same in this form and in *Erythraeodrilus*, and similarly with regard to the number and position of the seminal vesicles (three pairs in this form and in *Erythraeodrilus*, in segments ix, x, and xii; two, in ix and xii, in the other species of *Hoplochaetella*). The distinctive difference between *Hoplochaetella* and *Erythraeodrilus* is the presence of two pairs of prostates in the first, of one pair only in the second; in this, the present form agrees with *Hoplochaetella*, along with which I propose to include it, widening the previously given definition of the genus (as regards the endings of the vasa deferentia, the positions of the prostatic and spermathecal apertures, and the free testes and funnels) for the purpose.

Hoplochaetella spp.

Daman Road, N. of Bombay (between Bombay and Surat). 7-vii-1917. B. Prashad. Five specimens, none sexually mature.

Bombay, Malabar Hill. 1-vii-1917. B. Prashad. Numerous specimens, none mature.

Bombay, Elephanta Island, high up on a hill. 30-vi-1917. B. Prashad. Numerous specimens, none mature.

In the specimens from Malabar Hill the spermathecae could be seen on dissection to be just forming; they appeared to end in the furrows 7/8 and 8/9; if so, the approximation of the two pairs has not gone so far as in the majority of the species, where both pairs are on segment viii.

The specimens from Daman Road presented one point of interest to me. The type of the genus *Hoplochaetella* is Bourne's *Perichaeta stuarti*; and in identifying my former five species as belonging to this genus (13), one point which came up for discussion was that Bourne described certain diverticula of the intestine which I did

not find in any of my specimens ;—"In somites xxiii-xxvi (?) there are four pairs of special diverticula on the dorso-lateral portions of the intestine." In the example of the Daman Road batch which I dissected I noted that the segmental swellings and intersegmental constrictions of the intestine were very marked dorso-laterally in its anterior part ; and from about segment xxiii onwards for ten or a dozen segments there were very distinct lateral (not however dorso-lateral) sacculi, but their extent was rather indefinite. I did not, in my previous paper, consider the feature as of generic significance ; still it is perhaps some slight confirmation of my identification to find something similar (though not quite identical) in a worm which certainly belongs to the same group as those I there described.

Genus *Octochaetus*.

Octochaetus barkudensis, Stephenson.

Barkuda Island, Chilka Lake, Ganjam Dist., Madras Pres. ; at base of tree. 25-vii-1917 to 4-viii-1917. N. Annandale. Four specimens.

Same locality, date, and collector. Under stones on shore of island. One larger and a number of smaller specimens.

The papillae on segment viii may be joined in the middle line, and so appear as a dumbbell-shaped thickening.

In addition to the median oval papilla on segment xxii there may be a similar one on xxi.

Octochaetus fermori, Mchlsn.

Dhanu, a little distance N. of Bombay. 7-vii-1917. B. Prashad. Several specimens, immature.

Surat, W. India. 8-vii-1917. B. Prashad. Several specimens.

Ahmedabad, W. India. 11-vii-1917. B. Prashad. Several specimens.

Baroda, W. India ; by the banks of a tank. 9-vii-1917. B. Prashad. A single specimen.

Same place ; on a small hillock. 10-vii-1917. B. Prashad. One specimen, with perhaps two others, immature.

Gwalior, Central India ; bank of a stream. 17-vi-1917. B. Prashad. Five specimens.

Same place ; under flower-pots. 17-vi-1917. B. Prashad. A single specimen, rather immature.

Octochaetus paliensis, sp. nov.

Plate X, figs. 30-33.

Palia, between Indore and Ujjain, Central India. 27-vi-1917. B. Prashad. A single specimen, not in good condition.

Indore, Central India. 23-vi-1917. B. Prashad. Several specimens.

Poona. 3-vii-1917. B. Prashad. Two specimens, one smaller, not fully mature.

Bina, Central Provinces. 19-vi-1917. B. Prashad. A single specimen.

The description which follows is of the specimen from Palia, the one which was first examined. A few differences in the Poona specimens and in the one from Bina will be mentioned subsequently.

External Characters :—Length 45 mm. ; diameter 2.75 mm. Colour yellowish grey, not darker on the dorsal surface ; clitellum browner. Segments 141.

Prostomium apparently proepilobous (buccal cavity everted).

Dorsal pores from furrow 12/13.

Setae paired ; in front of the clitellum $ab = \frac{1}{3}aa =$ less than half (say $\frac{3}{7}$) $bc = \frac{2}{3}cd$; behind the clitellum $ab = \frac{2}{3}aa =$ half $bc = \frac{3}{4}cd$; in the middle of the body $ab = \frac{2}{5}aa = \frac{2}{3}bc$ and is slightly less than cd .

The clitellum extends over segments xiii-xvii (=5). Furrows are visible ventrally, but not dorsally ; dorsal pores are absent.

The male field shows two elongated trench-like depressions, on segments xvii and xix respectively ; these take up the whole length of the segments, and are thus separated by a transverse ridge which represents the ventral surface of xviii ; the trenches extend from a little outside the line of setae b to a corresponding point on the other side, and their lateral portions are rather deeper than the middle.

The prostatic pores are in these lateral portions, in line with setae b , on small white papillae. The seminal grooves pass longitudinally and straight between the pores of the same side.

The female pores could not be distinguished.

The whole of the ventral surfaces of segments viii and ix are thickened and somewhat flattened, forming a couple of low papillae, transversely much elongated, and with their lateral ends rounded ; these extend on each side to some distance outside the line of setae b . The spermathecal apertures appear to be just in front of the site of setae a of these segments, though setae a and b are not visible.

Internal Anatomy :—The first septum is probably $4/5$; this is moderately thickened. Behind this is a space in which lies the gizzard ; the next septum is $7/8$; this, and all the succeeding ones to 11/12 are somewhat thickened ; thereafter the thickening decreases as far as 14/15, after which all are thin.

The gizzard, in front of septum $7/8$, is spherical, and not very hard. There is a pair of large calciferous glands in segment xv, on the right side getting also into xiv ; each is kidney-shaped, with its convex margin indented. The intestine begins in xvii.

The last heart is in segment xii.

The excretory system is micronephridial.

Male funnels are free in segments x and xi ; testes were only doubtfully identified.

The seminal vesicles are in segments ix and xii. In the latter segment they are small, somewhat flattened, and lie within the curve of the hearts on each side. In segment ix I found none on the right side ; but on the left there was a fairly large, very deeply indented and lobed vesicle.

The prostates are two pairs of opaque, moderately thick, convoluted tubes, in segments xvii and xix, which bulge apart the septa. The duct is thinner, shining, wavy in its course, transverse in direction, and thinner in its first part than afterwards.

The ovaries are in the usual situation.

The spermathecae are two pairs. The ampulla is elongated, somewhat conical, of moderate size ; the duct is half as wide and one-third as long as the ampulla, not

sharply marked off, and not shining. The diverticulum is single, club-shaped, without distinct stalk, and in length one-third or one-fourth of the whole main pouch (ampulla *plus* duct); it arises from the ectal end of the duct (fig. 30).

The penial setae are in length $\cdot 65\text{--}\cdot 76$ mm., and their thickness at the middle is 16μ ; the shaft is straight, the distal end slightly curved, and the tip bluntly pointed; the ornamentation consists of about eight circles of small spines near the tip (fig. 31a). A second shape also occurs, with a somewhat sinuous outline at the distal end, and more sharply pointed tip (fig. 31b); this is possibly due to such setae being younger, and not fully straightened out.

The copulatory setae of segments viii and ix are in length $\cdot 76\text{--}\cdot 82$ mm., and 22μ thick in the middle. The proximal half is straight, the distal portion bowed; the tip is rather sharply pointed, and somewhat claw-shaped, with a slight swelling just proximal to the point. On the bowed distal portion of the shaft the convex and concave borders are furnished each with a row of spines, or incisions (fig. 32; in the example illustrated the spines stand off remarkably clearly; usually they are closely adpressed to the shaft).

In the specimen from Poona, the setal intervals were a little different:—in front of the genital region $ab = \frac{2}{5}aa = \text{half } bc = \frac{3}{4}cd$; behind the clitellum $ab = \frac{1}{5}aa = \frac{2}{7}bc = \frac{3}{4}cd$; in the middle of the body $ab = \frac{2}{5}aa = \frac{4}{7}bc = \frac{4}{5}cd$; dd is approximately $\frac{4}{7}$ of the circumference.

The trenches on the male field of the previous example are here contained within a somewhat thickened area, which extends posteriorly to the middle of segment xx, where it becomes joined to a transversely much elongated papilla; this papilla covers the posterior half of xx and the anterior half of xxi, and transversely is of equal extent with the trenches in front.

There seemed to be a very thin septum in front of the gizzard, corresponding to $6/7$; $5/6$ seemed to be the only missing one. Small ovisacs were present in segment xiv.

The spermathecal ampulla here has the form of an ovoid sac; the duct is hardly distinguishable. The diverticulum is a rather cauliflower-like cluster of small seminal chambers, with a short stalk (fig. 33).

In some of the penial setae the tip, instead of being rounded, appears to have sharp lateral edges. On the copulatory setae also there seems to be a lateral, rather thick ridge on the claw-like tip; this was more or less distinct in the previous specimen also.

In the specimen from Bina, the prostomium might be said to be compounded of the prolobous and tanylobous types,—a tanylobous prostomium with a transverse furrow at the anterior end of the “tongue” cutting it off from the projecting lobe in front. The relations of the setal intervals are scarcely sufficiently different from the type to deserve mention. The seminal vesicles, in ix and xii, were fairly bulky, and their margins were only slightly lobulated.

The spermathecae were, as seen in dissection, of the simplest possible form,—elongated sacs, narrowing somewhat at their ectal end, without diverticulum. On microscopical examination however a diverticulum was seen, bound down to the main sac; this was an ovoid simple appendage, showing no seminal chambers, entering the main sac rather nearer the ectal than the ental end; it was a little narrower towards its attachment, but there was no stalk; its length was a quarter, its thickness less than half, that of the main pouch.

The penial and copulatory setae were exactly those of the variety next to be described.

var. *riparius*, var. nov.

Plate X, figs. 34, 35.

Gwalior, Central India; on the bank of a stream. 17-vi-1917. B. Prashad. Four specimens.

Same place; in a garden. Same date and collector. Numerous specimens.

Same place; under flower-pots. Same date and collector. Two specimens.

External Characters:—The largest specimen examined was 90 mm. long, and 3·5 in diameter. Colour buff or yellowish grey, no difference between dorsal and ventral surfaces; the clitellum may have a reddish tinge. Segments 135.

Prostomium tanylobous or almost so; furrows at the sides of the tongue parallel, but may be only slightly marked.

Dorsal pores begin at the hinder border of the clitellum.

The setae are paired. The relations may be expressed thus:—In front of the clitellum $ab = \frac{1}{3}aa = \frac{2}{5}bc = \frac{3}{4}cd$; behind the clitellum $= \frac{2}{7}aa = \frac{2}{5}bc = \frac{3}{4}cd$; in the middle of the body $= \frac{1}{3}aa = \frac{2}{5}bc = cd$; dd in the middle of the body is equal to $\frac{5}{9}$ of the circumference.

The clitellum extends over segments xiii-xvii; it is thickened, well defined at both ends, the furrows obliterated but setae just indicated.

The male area is rather square, with thickened borders; it includes segments xvii-xix and the anterior half of xx, extending transversely across the whole ventral surface. This area presents a dumbbell-shaped depression, expanded on segments xvii and xix, the narrowed handle of the dumbbell being on xviii (*i.e.* the dumbbell is placed longitudinally); the narrowing of the depression on xviii is caused by two large flat papillae, continuous at their outer margins with the thickened edge of the general male area (fig. 34).

The prostatic pores are in the line of setae *b*, in the broadened ends of the dumbbell; the seminal grooves are convex inwards, skirting the inner border of the flat papillae.

The whole male field may be compared with that of the typical form by supposing that the lateral papillae of the present form have there extended mesially and joined, thus producing two separate depressions, one on xvii and one on xix (what I have called the “trenches”), with an intervening transverse ridge on xviii.

The female pores (or pore) are doubtless situated in a transversely oval area in front of the setal zone of segment xiv, which extends from a point between *a* and *b* on one side to a corresponding point on the other.

The ventral surfaces of segments viii and ix are thickened, as in the typical form ; these thickenings show each a pair of shallow depressions, approximately in the situation of the ventral pairs of setae (which however are not to be seen), and connected each with its fellow across the middle line by an irregular shallow trench. The spermathecal pores are in the depressed areas, rather in front of the middle of the segment, in the line of setae *a*, or between *a* and *b*.

Internal Anatomy :—Septum 4/5 is moderately thick ; the next is 7/8, which is somewhat thickened, as are all as far backwards as 13/14. The thickest of the series are 10/11 and 11/12 ; the thickening decreases by degrees in front and behind these ; there is some slight thickening even as far back as 16/17.

The gizzard is large and ovoid, occupying part of the space between septa 4/5 and 7/8. There is one pair of calciferous glands, in segment xv, with lobed outer margins. The intestine begins in xviii.

The last heart is in xii.

The micronephridia are small, numerous, and scattered irregularly.

Testes and funnels are free in segments x and xi ; these segments are filled out by masses of flocculent matter. The seminal vesicles, in ix and xii, are small.

The prostates are much coiled, in xvii and xix ; the relatively short duct is thinner than the glandular part, and passes inwards with an irregular bend at its beginning. A number of muscular bands, similar to those described by Michaelsen in *O. surensis* (4), are sufficiently prominent to attract attention.

The spermathecae are so exactly similar to those of the previously described specimen from Poona that no further account is necessary.

The penial setae, .7 mm. long, 18μ thick in the middle and 20μ at the proximal end, resemble very closely the second shape found in the type form ; the number of rings of spines is about a dozen.

The copulatory setae are .52 mm. long, and 20μ thick in the middle. They have the same bluntly pointed, slightly swollen and claw-shaped tip as the typical form. The convex and concave borders of the distal third of the shaft are furnished with thin serrated ridges (fig. 35), somewhat as if the spines of the typical form were bound to the shaft each by a delicate web. In addition, on the face of the seta which is presented to the observer under the microscope, a series of semicircular markings is seen ; but I am not quite clear what these actually represent.

In one, but only one, of the numerous specimens from the garden, an additional marking was present. This was a large slightly hollowed transverse papilla on the posterior half of segment xx and anterior half of xxi, extending from between *a* and *b* on one side to a corresponding point on the other, and joining the thickening of the male field along its anterior border (compare the specimen of the typical form from Poona).

Remarks :—The species is a very variable one,—in the characters of the prostomium, the external genital markings, the spermathecae, the penial and copulatory setae. Thus there are three well-marked kinds of spermathecal diverticulum,—simple

and attached to the ectal end, chambered and attached to the ectal end, and simple and attached (not merely attached but bound down by connective tissue) to near the middle of the sac. The variations are however so distributed that it is impossible to describe all the combinations as separate forms; the one that I have named (var. *riparius*) is distinguishable on external examination by the marked difference in the male genital area.

***Octochaetus prashadi*, sp. nov.**

Plate X, figs. 36-38.

Kalyan, near Bombay. 7-vii-1917. B. Prashad. A single specimen.

Sakarwari, on the way to Mahableshwar, W. Ghats. 4-vii-1917. B. Prashad. Two specimens.

External Characters:—Length 51-61 mm.; diameter 2.5-3.5 mm. Colour buff, no pigmentation, no difference between dorsal and ventral surfaces. Segments ca. 150; v and vi biannular, some or all of the rest up to the clitellum triannular.

Prostomium epilobous in varying degrees.

Dorsal pores from furrow 12/13 (there may be a rudimentary pore in 11/12).

There are some slight variations in the setal relations in the various specimens, but they are not very different from the following:—In the anterior part of the body $ab = \frac{2}{7}aa = \frac{2}{5}bc = \frac{3}{4}cd$, and the same behind the clitellum; in the middle of the body $ab = \frac{1}{3}aa = \text{half } bc = \frac{3}{4}cd$. The dorsal interval $dd = \frac{4}{7}$ of the circumference.

The clitellum is absent, or very faint and indefinite.

The male field shows a quadrangular thickening which includes part of xvi and extends backwards to the hinder border of xx; laterally it reaches to the line of setae *c*. On segments xvii and xix are transverse trench-like depressions, deeper in their lateral portions, where the prostatic pores are situated on rounded papillae in line with setae *b*. The general aspect of the male area is thus not unlike that of the last species.

Here again is the same difficulty. One of the specimens from Sakarwari, though corresponding closely in all other points, and especially in the peculiar penial and copulatory setae, differs markedly from the other examples in the configuration of the male field. The thickening is less extensive; it does not get on to segment xx, and laterally does not reach the line *c*; there are no transverse depressions. Just possibly the difference is due to the animal not being sexually as advanced as the others.

The female pores are perhaps represented by a pair of small whitish dots near the middle line on segment xiv, and nearly at the middle of the length of the segment.

The ventral surfaces of segments viii and ix are thickened, especially, it may be, round the sites of setae *a* and *b*; these setae may not be visible, or they may be seen, rather closer together than usual and shifted forwards nearer the anterior border of the segment. The spermathecal apertures are in furrows 7/8 and 8/9, conspicuous, in line with setae *b*, or between *a* and *b*.

Internal Anatomy:—Septum 4/5 is somewhat thickened, 5/6 is thin, and 6/7 absent. There is then some thickening as far as the clitellar region, most marked, perhaps, in septa 9/10 and 10/11, and decreasing in front of and behind these.

The gizzard is in front of septum 7/8, relatively large, globular, but not very firm. There is a large calciferous gland on each side in xv, projecting backwards also into xvi; each is divided into an anterior and a posterior lobe, and on the whole is kidney-shaped; the posterior ends approach each other, and are at a higher level in the segment than the anterior. The intestine begins in xvii or xviii.

The last heart was in segment xiii twice, in xii once.

The micronephridia are numerous and small.

Testes and funnels are free in segments x and xi; the funnels are of large size, or at least the iridescent mass which adheres to them is. The seminal vesicles are in segments ix and xii; they are slightly lobulated; both pairs may be of moderate size, or those in ix may be much larger than the posterior pair.

The prostates, in segments xvii and xix, are relatively large, and bulge apart the septa of the containing segments. The glandular part is a rather thick and opaque tube, closely coiled; the duct is much thinner, shiny, passing inwards with a bend or loop at its origin, or with a wavy course.

Ovaries and funnels occupy the usual situation; there were in one specimen minute empty ovisacs in segment xiv.

The spermathecal sac has a very stout duct which is not sharply marked off; the diverticulum is of considerable relative size, and has a very thick stalk; it arises from the spermathecal duct where the latter enters the body wall (fig. 36). So much can be said of all three specimens; but all three differ in details. The ampulla may be irregular in shape, or simply ovoid; the diverticulum may be almost as long as the main sac, or considerably shorter; it may be quite simple, or it may be slightly lobed, and on microscopical examination a few small seminal chambers may be distinguishable.

The penial setae (fig. 37) are in length 1.5 mm., and 40μ thick in the middle; the tip is slightly hooked, and rather hollowed or spoon-like on its concave side. The ornamentation consists of a large number of close-set rings of fine spines, which extend nearly half way along the shaft.

The copulatory setae are .8 mm. long, and 26μ thick at their middle. They are slightly bowed, and the tip is pointed; the distal portion of the shaft is marked by a number of scar-like depressions, with a general semicircular shape, and sharply defined, elevated and notched proximal margin (fig. 38).

Remarks:—In a number of details the present form remarkably resembles the last. The penial and copulatory setae however are very characteristic. There is no doubt however that this and the last are closely related species.

***Octochaetus montanus*, sp. nov.**

Plate X, figs. 39, 40.

Panchgani, W. Ghats, 12 miles from Mahabaleshwar; alt. 4,000 ft. 5-vii-1917. B. Prashad. A single specimen.

External Characters:—Length 60 mm.; thickness 3.5 mm. Colour buff, non-pigmented, slightly blotchy in places. Segments 158.

Prostomium epilobous $\frac{1}{2}$, the tongue separated from the projecting lobe in front, but not delimited behind.

Dorsal pores begin from furrow 10/11.

The setal relations may be expressed as follows:—On segment vii $ab = \frac{2}{3}aa = \text{half } bc = \frac{2}{3}cd$; behind the clitellum $ab = \frac{1}{3}aa = \frac{2}{3}bc = \text{half } cd$; in the middle of the body $ab = \frac{1}{4}aa = \frac{2}{7}bc = \frac{4}{7}cd$; $dd = \text{almost } \frac{2}{3}$ of the circumference.

The saddle-shaped clitellum takes up nearly eight segments, from near the anterior border of xii to xix inclusive.

The male field is a rectangular whitened area which includes the ventral surfaces of segments xvii-xix, and extends laterally to just outside the lines of setae *b*. The seminal grooves run longitudinally in line with setae *a*; the prostatic apertures, at the ends of the grooves, are not separately visible; the intersegmental furrows are visible, intersecting the seminal grooves at right angles.

An elongated, transversely oval genital papilla is present behind the male area, over the situation of furrow 21/22, depressed in its centre, where it covers the anterior half of xxii and the posterior of xxi; laterally it reaches on each side to the line of setae *b*.

Segment xiv presents a whitish pad mid-ventrally, on which the female pores are perhaps represented by a couple of darkish dots at about the middle of the length of the segment.

The spermathecal apertures seem to be in furrows 7/8 and 8/9, as a couple of whitish dots in line with *a*.

Internal Anatomy:—Septum 4/5 is moderately stout; 5/6 to 7/8 are very thin; 8/9 is somewhat thickened, 9/10 to 11/12 moderately so, 12/13 very slightly so.

The gizzard is in segment vi, of moderate size, squarish. The calciferous glands are two pairs, in segments xv and xvi, ovoid, antero-posteriorly compressed, and situated dorsally on the alimentary canal by the side of the dorsal vessel. The intestine begins in xvii.

The last heart is in xii.

The excretory system consists of scattered micronephridia.

Testes and funnels are free in segments x and xi. Two pairs of large seminal vesicles occupy ix and xii, those in xii meeting dorsally above the alimentary canal; both pairs are much lobulated,—indeed they might be described as racemose.

The prostates are two pairs, rather small. The glandular part is a rather thick opaque tube, with a few undulations but generally transverse in direction; the duct is very small, short and thin, also transverse in direction.

The large ovaries have the usual situation.

The spermathecal ampulla is an irregular sac; its duct is large, stout at its beginning and narrowing towards its ectal end, as long as the ampulla and fully half as thick in its ental portion. There is a single diverticulum, which arises from the duct at or above the middle of its length; it is finger-shaped on the whole, slightly swollen at its blind end, where a few seminal chambers are indistinctly seen (fig. 39).

The penial setae are in length up to 1.5 mm., but very thin,—only 6μ in thick-

ness at the middle. The shaft is rather bowed, and slightly undulating towards the tip; it tapers very gradually, and the tip is simply pointed; there is no ornamentation (fig. 40).

There are no copulatory setae in the spermathecal region.

Octochaetus pallidus, sp. nov.

Plate XI, figs. 41, 42.

Panchgani, W. Ghats, 12 miles from Mahabaleshwar; alt. 4,000 ft. 5-vii-1917. B. Prashad. Two specimens, one damaged in the clitellar region.

Mahabaleshwar, W. Ghats, 5,000 ft. 5-vii-1917. B. Prashad. A single mature specimen.

External Characters:—Length 40-44 mm.; diameter 2.5 mm. Colour pale yellowish, quite unpigmented, no difference between dorsal and ventral surfaces. Segments 166; segments vi-ix indistinctly triannular,—indeed this secondary annulation extends faintly as far back as the clitellum.

The prostomium differs in the two specimens from Panchgani; in the first it is prolobous, in the second somewhat epilobous, with a very broad angle behind, which is continued back by a median groove through segment i.

Dorsal pores from furrow 10/11; the first is small.

The setal relations may be expressed as follows:—In front of the spermathecae $ab = \frac{1}{3} aa = \text{half } bc = \frac{2}{3} cd$; behind the genital segments $ab = \frac{1}{3} aa = \frac{1}{3} bc = \text{half } cd$; at the middle of the body $ab = \frac{2}{5} aa = \text{nearly half } bc = \frac{3}{5} cd$; dd is equal to half the circumference or rather less at the middle of the body, but at the hinder end is only about one-third of the circumference.

The clitellum is saddle-shaped, and extends over xiii-xvii (= 5).

The male field is represented in the undamaged Panchgani specimen by a thickening on the ventral surface of segments xvii-xix, which extends outwards to a little beyond the lines of setae *b*. The prostatic pores are in the line *b*, and the seminal grooves lie just outside this line, straight and longitudinal in direction, curving inwards at their extremities to end at the pores; the grooves are close to the edge of the whitish area.

In the specimen from Mahabaleshwar the field was rather more extensive, and circular in shape, it embraced portions of segments xvi and xx, and reached outwards to *c*. The prostatic pores were situated each in a small transverse groove.

The female pores are paired, on minute papillae a little internal to and in front of the site of setae *a*.

The spermathecal pores are two pairs, at the site of setae *a* on segments viii and ix; they are represented by small round papillae, white at their summits, but definite apertures were not present.

Internal Anatomy:—Septum 4/5 is thin, 5/6 and 6/7 very slightly strengthened, 7/8-11/12 all somewhat thickened, 12/13 only very slightly so; the rest are thin.

The gizzard is barrel-shaped, in segment vi; the oesophagus is distinctly strengthened in segment v also, where shining longitudinal muscular bands are seen. This seems to be the beginning of a double gizzard, such as is seen in *Eudichogaster*,

Dichogaster, and *Trigaster*; I do not however suggest at present that any of these genera are derived from this species, or indeed from the genus *Octochaetus* at all.

There are no calciferous glands. The intestine begins in xvi.

The last heart is in segment xii.

The excretory system is micronephridial. In the postclitellar segments the organs are few in each segment and of moderately large size; they are placed in a transverse row in each segment, about seven on each side, and in each row they increase in size from the ventral end of the row as far as the fifth nephridium, but the two most dorsal are smaller again. This was the condition in the anterior part of the animal,—in that part usually opened for dissection; on opening the posterior part of the specimen the difference in size was found to disappear towards the hinder end.

A curious modification of the nephridia, which I have not seen before, was found in segments xi and xii. In each of these segments a ventrally situated pair of structures attracted my attention; these appeared at first to be flattened bags, rather oval in shape, taking up approximately the whole length of the segment from one septum to the other, and attached by a stalk at their inner ends to the body-wall near the middle line. They could be detached from the body-wall except where they were attached by the stalk; there was nothing to correspond externally. They were present in the same segments and the same position in the second worm from Panchgani. Microscopically they were found to be masses of micronephridial tubules, arranged in a compact series of parallel loops, the loops running transversely to the long axis of the oval mass.

Testes and funnels were free in segments x and xi, along with much flocculent matter.

There are two pairs of seminal vesicles, in ix and xii. Both pairs are of moderate size; those in xii are racemose, those in ix have almost smooth borders.

The prostates are two pairs; they are tubular, of moderate size, the glandular part consisting of a series of apposed loops. The duct is very narrow at its beginning, but soon widens; it makes a complete bend, and then passes inwards and slightly forwards; it is of some length, straight after the initial bend, stout and shining.

The ovaries are in segment xiii; ovisacs are present in xiv.

The spermathecal ampulla is elongated, narrower towards its blind end, swollen near its base, of moderate size; the duct is quite short, and appears dilated, so as to be subglobular. The diverticulum is single, stalked, rounded, about equal in size to the duct, to the side of which it is attached; the diverticulum shines with contained spermatozoa, but is not chambered (fig. 41).

The penial setae (fig. 42) are .79 mm. long, and 7 to 8 μ thick at the middle. The shaft is slightly bowed, and tapers gradually towards the tip; the point is fairly sharp, and there is no ornamentation, but the distal end of the seta has a curious wavy outline.

Remarks :—The present form appears to be related both to the last (smooth penial setae), and also to the anomalous and somewhat problematical *O. bishambari*

which I described some time ago (9); in addition to having smooth penial setae the latter species has, like the present one, no calciferous glands.

Octochaetus ganeshae, sp. nov.

Plate XI, figs. 43-45.

Ganeshkhind, 4 miles from Poona. 3-vii-1917. B. Prashad. Three specimens.

Londa, 10 miles from Castle Rock, W. India. 6-vii-1917. B. Prashad. One specimen, an anterior fragment, not fully mature.

External Characters:—Length 43 mm.; diameter 2.5 mm. Colour unpigmented, pale except where matter in the alimentary canal shows through the body-wall. Segments 150.

Prostomium epilobous to a somewhat varying extent, about $\frac{3}{4}$; sides of tongue parallel, or (once) converging behind to form a Y-shaped figure.

Segments v and vi biannular, thenceforwards as far as the clitellar region triannular.

Dorsal pores from furrow 12/13.

Setal ratios may be expressed as follows:—Behind the genital region $ab = \frac{1}{4}aa = \frac{2}{5}bc = \frac{3}{4}cd$; in the middle of the body $ab = \frac{1}{3}aa = \frac{2}{5}bc = \frac{3}{4}cd$; but apparently different specimens show slightly different ratios. In front of the genital region the setae are small and difficult to see. The mid-dorsal distance dd is almost two-thirds of the circumference.

The clitellum is absent, or not developed in these specimens.

The male field is a slightly raised whitish area,—more raised towards its lateral margins,—rectangular in shape, including segments xvii-xix and extending outwards on each side rather further than half way between the lines of setae b and c . The prostatic pores are between the lines of a and b , and the seminal grooves are almost straight, slightly bowed inwards.

The female pores are marked by a pair of minute indistinct papillae anteriorly on segment xiv and internal to the line a .

The spermathecal apertures are minute slits on segments viii and ix, just in front of and between the two setae of each ventral couple.

Internal Anatomy:—Septum 4/5 is moderately strengthened; 5/6 and 6/7 are absent, 7/8 and 8/9 are slightly thickened, 9/10 to 11/12 considerably so, 12/13, 13/14, and even 14/15 slightly so.

The gizzard is of moderate size, rounded, and situated in the space between septa 4/5 and 7/8; probably it is morphologically in vi, since there are soft-walled portions of the canal both in front of and behind it within these limits.

The calciferous glands, in the specimen from Ganeshkhind first examined, are in xv, of moderate size, confined to this segment, somewhat kidney-shaped, slightly lobed, attached to the gut by the hilus, and meeting dorsally over the gut. In the specimen from Londa the glands took up part of two segments, xv and xvi, and were mainly in the latter; they were deeply incised by the septum.

The intestine begins in xvii or xviii.

The last heart is in xii.

The micronephridia are arranged in a single transverse row in each segment.

Testes and funnels are large and free, in segments x and xi. Seminal vesicles occupy segments ix and xii; both pairs are of moderate size, and slightly lobed.

The tubular prostates consist of a few coils only. The duct is about half the thickness of the glandular portion, of the same diameter throughout, soft and semitransparent, passing with an undulating course transversely inwards.

The female organs have the usual situation.

The spermathecal ampulla is an elongated sac, narrower towards its blind end, almost sessile on the body-wall, so that a duct cannot be separately distinguished. There is a single diverticulum, which may appear simple, or may show a few small lobulations; it is small, and attached by a short stalk to the base of the ampulla where this joins the body-wall (fig. 43).

The penial setae (fig. 44) are .42 mm. long (possibly longer when fully developed), and 10μ thick at the middle. The shaft is almost straight, slightly bowed towards the distal end; the tip is pointed and slightly hooked; the ornamentation consists of a few circles of fine spines near the tip, principally visible as fine irregularities of the edges of the seta.

The copulatory setae of the spermathecal segments are in length .27 mm., but here also the full length may not have been attained; they are 10μ thick at the middle. They are not very different in type from the penial setae; the shaft is straight for the most part, slightly bowed towards the tip, which is bluntly pointed and somewhat claw-shaped. The ornamentation consists of a number of fine spines on the convex and concave borders of the terminal portion of the shaft; in the specimen from Londa a few incomplete rings were seen (fig. 45).

***Octochaetus pachpaharensis*, sp. nov.**

Plate XI, figs. 46, 47.

Pachpahar, about 40 miles S. of Kotah, Rajputana. 13-vii-1917. B. Prashad. Five specimens.

External Characters:—Length 28 mm., diameter 1 mm. Unpigmented. Segments 95.

Prostomium broad, slightly epilobous, tongue not cut off behind.

Dorsal pores from furrow 7/8.

Setal relations not easy to determine in such a small worm,—perhaps in general $ab = \frac{2}{7} aa = \frac{2}{5} bc = \frac{2}{3} cd$; dd is slightly less than half the circumference.

The clitellum extends over segments xiii — $\frac{2}{3}$ xviii ($= 4\frac{2}{3}$). It is saddle-shaped except on xiii or xiii and xiv, where it is complete.

The prostatic pores, and the straight seminal grooves, are between the lines *a* and *b*.

The female pores are apparently paired, on the anterior part of segment xiv.

The spermathecal apertures were not visible externally; on dissection they appeared to be in grooves 7/8 and 8/9.

Internal Anatomy :—Septum 5/6 is somewhat thickened, 6/7 considerably, 7/8, 8/9 and 9/10 much thickened, considering the size of the worm ; 10/11 to 13/14 are also somewhat strengthened.

There is a rudimentary gizzard in segment vi, of fair size, barrel-shaped, but soft ; it appears as shining longitudinal bundles of muscular fibres. The large lobes of the pharyngeal glands occupy much space in segment v. There are no calciferous glands. The intestine begins in xiv.

The last heart is in xii.

The excretory system is micronephridial. Behind the genital region there are three nephridia on each side in each segment, with the form of flattened coils (not the flattened plate-like organs of *Dichogaster*, where similarly there are only a few nephridia on each side in each segment). In front of the prostatic region there are even fewer, perhaps only one on each side in some segments (?).

Testes and funnels are free in segments x and xi (judged from the flocculent masses in these segments, which pass deep in the segments into the iridescent covering of the funnels ; testes were not separately identified). Seminal vesicles are present only in xii, as rounded masses which may meet dorsally over the alimentary canal.

The prostates are two pairs, tubular, of fair length and sometimes extending beyond their own segment, bent several times. The duct is much thinner than the glandular portion, almost straight, and shining.

Ovaries are present in segment xiii, and ovisacs in xiv.

The spermathecal ampulla is an exceedingly irregular and deeply lobed sac (fig. 46) ; the duct is as long as or longer than the ampulla, but relatively narrow, of the same diameter throughout, firm and shining. What I think is the diverticulum (since in one specimen it contained iridescent spermatozoa, which the main sac never does) is a saccule attached to the ental end of the duct, much resembling one of the lobes into which the ampulla is incised.

Two spermathecae were found on the right side in segment viii, opening side by side ; this is presumably an individual anomaly.

The penial setae are bent into about two-fifths of a circle, and measure across the bend 7 mm. ; the thickness at the middle is 12 μ , but at the proximal end 20 μ . The shaft tapers gently towards the distal end, which does not quite continue the direction of the curve, but is slightly bent in the contrary direction. The tip is somewhat wavy, and ends in a fairly sharp point. The ornamentation consists of a number of irregular rings of small teeth on the distal portion of the shaft, the terminal portion however being smooth.

Remarks :—The absence of calciferous glands, with the small number of nephridia per segment, allies this form to the group of *pallidus* and *bishambari*.

Genus **Eutypheus**.

Eutypheus incommodus (Bedd).

Bharatpur, E. Rajputana. 15-vii-1917. B. Prashad. Two specimens,

Eutyphoeus mohammedi, Stephenson.

Rawal Pindi, N. Punjab. June-July 1917. R. Hodgart. A single specimen.

This worm has been recorded only once previously, from Allahabad (9). I add a few notes on the external characters of the present specimen; the internal anatomy corresponds exactly with that of the type.

The length of the present example was only 39 mm.; its maximum diameter, behind the clitellum, where it was perhaps unnaturally swollen, was 4.75 mm.; the worm is thus short and stout. Segments ca. 160, all very short behind the clitellum. The prostomium showed no projecting lobe,—perhaps this was withdrawn within the buccal cavity; a couple of parallel grooves on the dorsal surface of the first segment indicated that it was tanylobous.

The setal intervals were as follows:— $ab = \frac{1}{3}aa = \frac{2}{3}bc = \frac{3}{5}cd$; but in front of the clitellum the mid-ventral distance aa becomes much smaller.

The male pores were situated on distinct papillae.

Eutyphoeus chittagongianus, Mehlsn.

Above Tura, Garo Hills, Assam; 3,900 ft. On paths after rain. July-Aug. 1917. S. W. Kemp. Two specimens $W \frac{1.7}{1}$, $W \frac{1.7}{1}$.

Above Tura, Garo Hills, Assam; 3,900 ft. July-Aug. 1917. S. W. Kemp. Two specimens $W \frac{1.62}{1}$, $W \frac{1.68}{1}$.

Sureil, Darjiling Dist.; 5,000 ft. 11-31-x-1917. N. Annandale and F. Gravely. A single specimen.

Nam Ting Pokri, Darjiling Dist.; 4,600 ft. June-July 1918. S. W. Kemp. A single specimen.

This worm has been described by Michaelsen (3) from two specimens in a bad state of preservation. I therefore add a few notes to supplement the original account.

External Characters:—The length is various, from 182 to 405 mm.; the maximum diameter is as much as 10 mm. The colour may be a medium olive dorsally, lighter below; or the worm may be almost unpigmented throughout.

Secondary annulation is well marked on the anterior segments; iv and v are biannular, vi has two chief and two subsidiary furrows, and succeeding segments as far as the clitellum are primarily triannular, with secondary furrows on the first and last annuli; the post-clitellar segments may also be triannular.

Setae seem to be sometimes absent on the first four or five segments.

The male pores, each sunk in a separate pit in Michaelsen's specimens, are often contained in a large transverse furrow which extends across the ventral surface; this furrow has rounded but not tumid lips, and on looking into it the male pores are seen on small transversely oval papillae in the line of setae b .

The spermathecal apertures, in b in Michaelsen's original specimens, and in some of mine, may be between b and c .

The genital markings, described in the original account as "intersegmental

areas," are seen in better preserved specimens to be clean-cut depressions, mainly on the posterior annulus of the anterior of the two segments with which they are in relation. These may occur also on furrow 10/11.

In some of my specimens there is a tendency for the post-genital depressions to divide into two (as in *E. kempfi*; see below, *Remarks*); and low flat papillae may be present within some of the depressions.

Internal Anatomy.—The dorsal vessel, as in many species of the genus, does not extend forwards to the anterior end of the body; it gives off two pairs of lateral commissures in front of septum 8/9, and is not traceable beyond this,—it does not get on to the gizzard.

The micronephridia behind the genital region are arranged as a transverse row of small organs in each segment just behind the attachment of the septum; from the prostatic region forwards they are numerous and irregularly scattered.

Testis sacs, about which Michaelsen was in some little doubt, are present, large and subspherical, in xi, lying against septum 10/11; they are contiguous, and apparently communicate with each other, beneath the alimentary canal.

The spermathecal duct is practically absent, the ampulla being sessile on the body-wall and attached by a portion of its under surface; if a duct is described, it would be very short and stout. The broad fan-shaped diverticulum is often divided into two;—not always, and when undivided it may appear like a flange surrounding the greater part of the attachment of the ampulla to the body-wall. The number of seminal chambers appears to be about twenty.

The penial setae vary in length from 2 to 5 mm., and in thickness from 30 to 40 μ ; some of the difference in length may be due to the growth of the shorter not having been completed. The extent of distribution of the small teeth on the distal end varies. Even when fully formed setae were projecting from the male pores, the distal ends seemed to be often soft and perhaps deformed; Michaelsen had the same difficulty. The typical form of the tip seems to be broadened and perhaps spoon-shaped.

Remarks.—I have come to the conclusion that *E. kempfi*, which I described from the Abor country (8), must be identified with the present form. The difference in form and distribution of the genital markings, and in the penial setae, are not sufficient to justify its separation, when one takes into consideration the variations that are now known to occur.

It might be justifiable to separate the specimens from Sureil and Nam Ting Pokri as a distinct variety, on account of (i) absence of pigment, (ii) spermathecal apertures midway between *b* and *c*, (iii) genital markings as pairs of oval depressions, those of a pair being contiguous in the middle line in furrows 19/20, 20/21, and 21/22, (iv) the tip of the penial setae free from ornamentation and smooth, while on the other hand, the minute spines extend further up the shaft than in the typical form. But the forms I previously described as *E. kempfi* show an intermediate condition as regards (ii) and (iii), and in them too the tip of the penial setae is free from spines, though these do not extend far up the shaft.

Eutyphoeus waltoni, Mchlsn.

Delhi. 15-vii-1917. B. Prashad. Eight specimens.

Gwalior, Central India ; on the bank of a stream. 17-vi-1917. B. Prashad. Four specimens.

Ahmedabad, Bombay Pres. 11-vii-1917. B. Prashad. Numerous specimens.

Baroda, W. India. 9-vii-1917. On banks of Vishvamitri River. B. Prashad. Two specimens, one immature.

Same place ; in a garden. 9-vii-1917. B. Prashad. Several specimens, all or mostly immature.

Same place ; by the side of a tank. 9-vii-1917. B. Prashad. Four specimens.

Same place ; on a small hillock. 10-vii-1917. B. Prashad. Five specimens.

Same place ; in a garden. 10-vii-1917. B. Prashad. A number of specimens, mostly immature.

Navli, between Baroda and Ahmedabad. 10-vii-1917. B. Prashad. Four specimens, immature.

Calcutta ; banks of Hugli River, in partly saltish water. 23-viii-1918. B. Prashad. Four specimens, not fully mature.

The species is common in India, and is already well known. The present large number of specimens, of varying degrees of maturity, has led me to the conclusion that *E. bengalensis* Mchlsn. (3) has no separate existence, and is only an immature form of *E. waltoni*. In going over the above batches of specimens I had at first no suspicion of this, and diagnosed those from Delhi, Navli, and three of those from Baroda as *E. waltoni*, while I put down the worms from Gwalior, Ahmedabad, and two of the batches from Baroda as *E. bengalensis* ; I began to have doubts however during the progress of the work, and with regard to one of the batches from Baroda, of worms of varying degrees of maturity, I could feel no certainty. The Calcutta specimens I at first thought to be a new species. It seems to be the case that *E. waltoni* produces its penial setae early, and that these may be well developed before the clitellum and characteristic genital markings show themselves.

I may perhaps be allowed to discuss shortly the differences between the two species, according to Michaelsen's original descriptions (3).

E. waltoni would appear to be a much larger worm ; the lower limit of length for *E. waltoni*, however, is not very different from the length of Michaelsen's single specimen of *E. bengalensis* (*waltoni* 90-230 mm., *bengalensis* 72 mm.—by a misprint given as 12 mm.).

The prostomium of *waltoni* is tanylobous, of *bengalensis* prolobous. I have previously described the prostomium of *waltoni* as combined pro- and tanylobous,—tanylobous with a transverse groove in front of the tongue ; Michaelsen does not distinguish this form of prostomium from the typical tanylobous, without the transverse groove. In one of my specimens which I put down as *bengalensis* without hesitation, the prostomium was tanylobous.

As may be seen from a number of the species referred to in previous pages of this paper, small differences in the setal ratios are of no importance ; I may mention however that similarly in one of the present series of specimens, which I had no doubt about identifying as *bengalensis*, the ratios were exactly those given for *waltoni*.

Michaelsen does not mention the clitellum of *bengalensis*, and it was presumably absent. This I take to be a sign of immaturity. The same may be said of the absence of the genital markings.

The original account of *bengalensis* has "testes and sperm-duct-funnels free (?)"; my note on the specimens which I did not doubt, at the time, were *bengalensis* runs "I think sperm-sacs; the membrane is certainly very thin, but to the best of my observation it exists." *E. waltoni* has a common sperm-sac; so that there is probably no difference here.

One chief difference is that the penial setae of *waltoni* are beset with minute spines near the tip, while those of *bengalensis* are smooth (the shape is much the same). I have already noted (9) that I could not identify distinct spines even with the oil immersion lens in some specimens of *waltoni*; and in the present series, among those which are undoubtedly *waltoni*, I have twice found the spines absent from the spoonshaped tip, though a few were seen further up the shaft.

Lastly the spermathecal diverticula are said to be on opposite sides of the duct in *bengalensis*, side by side in *waltoni*; in some of the present series of *waltoni* however I have found them opposite each other.

Eutyphoeus turaensis, sp. nov.

Plate XI, figs. 48, 49.

Above Tura, Garo Hills, Assam; 3,500-3,900 ft.; in rotten wood. July-Aug. 1917. S. W. Kemp. Four specimens, one somewhat damaged. W $\frac{1.8.1}{1}$.

Same place, date, and collector. Under bark. Three specimens, immature. W $\frac{1.7.8}{1}$.

External Characters:—Length 100 mm.; maximum diameter 3.5 mm. Colour light grey, unpigmented; no difference between dorsal and ventral surfaces. Segments 171; segments long in front of, short behind the male apertures. Segments v and vi biannular or indistinctly triannular, vii triannular, viii and ix triannular with other secondary furrows also, x triannular, xi indistinctly so.

Prostomium small, tanylobous, tongue broader behind than in front.

Dorsal pores from furrow 11/12.

Setae are scarcely visible on segments ix and x, while they are enlarged on iii. vi. The intervals may be expressed thus:—Anteriorly $ab = \frac{1}{3}aa = \text{half } bc = \frac{3}{4}cd$; behind the clitellum $ab = \frac{1}{4}aa = \frac{2}{5}bc = \frac{2}{3}cd$; in the middle of the body $ab = \frac{1}{3}aa = \text{half } bc = \frac{3}{4}cd$; dd is nearly equal to two-thirds of the circumference.

The clitellum is very slightly marked; all that is to be seen is some thickening ventrally on segments xv to xvii.

The male pores, on segment xvii, are in a pair of narrow transverse depressions which extend over an interval greater than ab , the limits of the depressions being inside the line a and outside b ; penial setae, marking the site of the aperture, protrude in the line b .

The female apertures were not visible.

The spermathecal apertures are in furrow 7/8, in the line b .

Genital markings are faintly visible in furrows 14/15, 15/16, and 16/17, in line with *a*, as inconspicuous slightly pigmented spots surrounded by circular grooves.

Internal Anatomy:—Septa 4/5 and 5/6 are moderately stout; the next is 8/9, which is somewhat displaced backwards; this septum and the two following are rather close together, and are all somewhat strengthened; 11/12 is absent, as in *E. waltoni* and many others of the genus; 12/13 is very thin, and is bulged backwards to the level of 14/15 by the seminal vesicles; the rest are also thin.

The gizzard is barrel-shaped, situated in the long space between septa 5/6 and 8/9. Calciferous glands are represented by an ovoid dilatation of the alimentary canal in segment xii, with transverse vascular striations. The intestine begins in xv.

The last hearts are in xiii; those of xi are bound down by connective tissue to the walls of the oesophagus. The dorsal vessel seems not to be continued forwards beyond the gizzard, ending by giving a pair of commissures at the anterior end of this organ.

The micronephridia are arranged in a transverse row in each segment behind the clitellum; in the dorsal half of each segment there are pretty regularly three on each side.

The testis sacs are one pair, in segment xi; they are separate from each other and longitudinally elongated, lying by the side of the nerve cord. They are connected with the seminal vesicles in segment xii; these are large, two-lobed, the lobes being anterior and posterior; each lobe is subdivided by further indentations; they extend back to the level of 14/15 by bulging back the septa.

The prostates are small, occupying segments xviii and xix; the coils are closely packed. The duct is not markedly different from the glandular part; it is scarcely narrower, is soft, not shining, and passes forwards and inwards with an undulating course.

The female organs were not identified.

The spermathecae (fig. 48) are elongated sacs lying longitudinally on the body-wall, to which they are attached by a portion of their under surfaces; a duct can thus hardly be described,—it would at any rate be called very short and stout. The diverticula are two, one on each side, attached to the junction of sac and duct by a short relatively stout stalk; each shows a lobulation which indicates the presence of three or four seminal chambers.

The penial setae (fig. 49) are in length up to 1.5 mm., and in thickness 35μ ; the distal half is slightly curved, and the tip bluntly pointed and rather claw-like. The ornamentation consists of very fine dot-like markings over the distal eighth or tenth of the length of the shaft, including the tip.

Remarks:—This species appears to be allied to *E. chittagongianus*; the internal anatomy is remarkably similar, and the chief difference between the two is in the genital markings. Although the present specimens were possibly not quite mature, it seems fairly safe to say that the markings differ in both character and position in the two forms.

Subfam. *TRIGASTRINAE*.

Genus **Eudichogaster**.

Eudichogaster ashworthi, Mchlsn.

Plate XI, figs. 50, 51.

I have lately received, by the kindness of Dr. J. H. Ashworth, two specimens of this species, of the same batch which furnished the types of the species described by Michaelsen (2). I need only add very few notes on the peculiarities exhibited by these.

The papillae of the spermathecal pores are not always symmetrical; in the specimen to which I devoted most attention, the papilla on the right side of segment viii took up about the middle two-fourths of the segment, that on the left side the anterior half; those on ix took up the anterior two-fifths of the segment, and encroached somewhat on the intersegmental furrow.

The gizzards in segments v and vi are short, and do not include the whole length of the oesophagus in these segments; a soft ring is thus left between the two, and another between the second and the hinder limit of its segment.

The specimen differed from Michaelsen's in the seminal vesicles; instead of vesicles in ix and xii, I find a pair in xii, a pair in x attached to the posterior septum of the segment, and a single vesicle in ix, on the left side only (one specimen only dissected).

I think Michaelsen's paper contains a slip where he speaks, in the diagnosis and again in the detailed description, of the diverticulum of the spermatheca entering the distal end of the duct. Michaelsen always uses the word distal to mean "nearer the surface of the body" (in such a case as the present, when speaking of an internal organ); the diverticulum however enters the duct at the ental end of the latter, just below the ampulla, and the same is the case in the numerous specimens to which reference is made below.¹

The copulatory setae are, according to Michaelsen, found on the papillae of the male field (but not in connection with the prostatic apertures), and doubtfully in the neighbourhood of the spermathecal apertures; they are of a well defined type. In the specimen which I dissected I found them in the neighbourhood of the spermathecal

¹ There is a difference in the use of the words "proximal" and "distal" by English and German writers. I was taught to use them for "nearer to" and "remoter from, the fixed point of attachment"; and Beddard, for example, among writers on this group, uses the words in the same sense. Thus in such an organ as the spermatheca, which is attached by its duct to the inner surface of the body-wall and projects freely inwards into the coelom, a diverticulum attached to the duct near the body-wall would be proximal, and one attached to the duct near the ampulla would be distal as compared with the other. So for example in a well-known elementary textbook it is said that the testes of *Hydra* are distally situated, *i.e.* near the oral and distant from the fixed end of the animal. Michaelsen not infrequently queries Beddard's use of the words, and himself employs "proximal" and "distal" to signify respectively "nearness to" and "remoteness from, the central axis of the body." In view of this confusion I have for some time past used "ectal" and "ental" to signify "nearness to the surface of the body" and "nearness to the internal end," in the case of such structures as those under discussion.

pores, but not in the male region; for ready reference they are shown in fig. 50. From my examination of the specimens which are referred to below, I do not doubt that when special setae are found near the spermathecal pores they are of this type; but I have never found setae of this form in the neighbourhood of the male field, though other more slightly modified forms are not uncommon there.

Choral, between Khandwa and Indore, Central India. 23-vi-1917. B. Prashad. One sexual specimen and others smaller, doubtfully of the same species.

Saugor, Central Provinces. 20-vi-1917. B. Prashad. A single specimen.

Bina, Central Provinces. 19-vi-1917. B. Prashad. Numerous specimens, mostly immature, only three with sexual marks.

Teor, 8 miles from Jubbulpore, Central Provinces. 22-vi-1917. B. Prashad. A single specimen.

Partabgarh, S. Rajputana. Feb. 1918. Col. J. Manners-Smith. Two specimens, one immature, the other scarcely fully mature.

Poona, W. India. 3-vii-1917. B. Prashad. Several specimens, apparently mostly not fully mature.

Wahi, on the way to Mahableshwar, W. Ghats. 4-vii-1917. B. Prashad. Six specimens, two with sexual marks.

Some of the above specimens appeared at first to be worthy of separation as distinct varieties, on the ground of differences between them and Michaelsen's description,—especially as regards the copulatory setae of the spermathecal segments and of those of the neighbourhood of the male field, joined with the difference in the attachment of the spermathecal diverticulum. But a careful comparison of the specimens among themselves, and the examination of the co-types of the species, has shown me that the differences are not of great importance.

The majority of the specimens encountered are not fully mature; the clitellum is often wanting, even when all other marks of maturity are present. The length is often much less than that of the original examples;—lengths of 45, 56, 67 and 75 mm. were met with, in each case the best developed of the batch being measured.

The first segment may be divided by a median longitudinal furrow behind the prostomium.

The dorsal pores may begin in II/I2 instead of I2/I3.

The papillae on or near the male field are variable. Those on xvi, or those on xx, may be absent; and I have not seen the paired papillae on segments xvii and xix internal to the male pores; there may however be median papillae on these segments.

Similarly with the papillae of the spermathecal region. In addition to those described by Michaelsen, there may be a pair on segment viii similar to those on ix outside the line of setae *b*, and a median papilla, it may be of considerable transverse extent, on x.

The seminal vesicles are in ix and xii, or in xii only; in this latter case it is possible that a second pair would have developed at a later stage. The prostatic duct is often straight, or only slightly bent; but the explanation may be the same.

The spermathecal diverticulum is in all cases attached to the ental end of the duct, or in one specimen to the base of the ampulla.

The copulatory setae of the spermathecal region, when found, are of the form

already mentioned. They are always longer than the measurement given by Michaelsen (who gives .24 mm.),—usually about .5 mm., and not less than .4 mm.

The modified setae in the neighbourhood of the male field are not always, according to my experience, to be found. They are much less modified than those of the spermathecal region, and may even still retain the ordinary double curve with the nodulus; the sculpturing consists of a number of fine semicircular lines, concave towards the tip of the seta, or of a few faint transverse rows of closely set dots, or of zigzag lines which indent the surface of the seta sufficiently to produce irregularity of the margins (fig. 51).

Eudichogaster bengalensis, Mchlsn.

Bheraghat, Marble Rocks, 13 miles from Jubbulpore, Central Provinces. 22-vi-1917.

B. Prashad. A single specimen.

The present species has been described by Michaelsen (4). As this is the second time it has been encountered, a few notes may be added to supplement the original account.

The prostomium I should describe as proepilobous, with a pair of shallow grooves dorsally on segment i; the grooves extend back over three-quarters of the segment, but not as far as the intersegmental furrow.

The first dorsal pore I found in furrow 11/12.

My specimen showed a series of papillae in the spermathecal region,—three pairs, on segments viii, ix, and x, oval in shape, white, including and extending beyond the setae *ab* both inwards and outwards.

The last heart is in segment xii.

As the nephridial system has been shown by Michaelsen to be of importance in this genus, and as his specimens were considerably softened and so not favourable for examination, I give the results of my own dissection. The individual micronephridia are large and few; two longitudinal series are to be seen on each side of the body in and behind the prostatic region; *i.e.* there are only two on each side of each segment. At about one-third of the length of the animal from the posterior end the two are still present, and similar in appearance; though the outer, which extends on the body-wall from the site of seta *c* to half-way between *d* and the middorsal line, is larger than the inner, which only takes up a space equal to the interval *bc*. A little behind this the inner becomes more opaque and rather bulkier than before, and so more conspicuous. Towards the hinder end it maintains these characters, and increasing in size also so as to include the interval *a* to *c*, it becomes much more conspicuous than the outer nephridium, which has rather diminished in size. I think there may be a few very minute micronephridia on the body-wall in addition to the series described above, but the condition of the specimen is none too good, though apparently better than Michaelsen's.

The penial setae are not ornamented so markedly as in the type. The spines are extremely fine, and are arranged in short transverse rows; there is no specially projecting brush-like circle near the tip.

Eudichogaster trichochaetus, sp. nov.

Plate XI, figs. 52, 53.

Bombay, Victoria Gardens. 30-vi-1917. B. Prashad. Numerous specimens, some immature.

Bombay, near Colaba Railway Station. 1-vii-1917. B. Prashad. Seven specimens.

Bombay, under a tree near the Fort. 30-vi-1917. B. Prashad. Three specimens.

Palchar, N. of Bombay, between Bombay and Surat. 7-vii-1917. B. Prashad. A number of specimens. Two showing sexual marks.

External Characters.—Length 32–45 mm.; diameter 1.75–2.25 mm. Colour a yellowish grey, no difference between dorsal and ventral surfaces. Segments 103–128.

Prostomium epilobous 2/5, pointed behind, the point continued back as a groove which divides the dorsal surface of the first segment; or in some cases the prostomium itself appears to be prolonged backwards so that the point is at the furrow 1/2.

Dorsal pores begin from furrow 12/13 or 13/14.

The ratios of the setal intervals may be expressed thus:— $ab = \frac{1}{3}$ to $\frac{2}{3}aa = \frac{1}{2}bc = \frac{3}{4}cd$ from behind the male genital region backwards; in front of the clitellum the ratios are less regular, but ab is certainly wider, equal about to half aa ; dd is nearly half the circumference.

I have never found a recognizable clitellum.

The male field is a rectangular thickening, whitish in colour, taking up segments xvii–xix, and extending laterally on each side to between the lines of b and c ; it may extend slightly on to segments xvi and xx. The prostatic apertures are small transverse slits corresponding in extent to the interval ab , on segments xvii and xix. The seminal grooves pass longitudinally between the outer ends of the prostatic pores of the same side, and are thus in the line b , and some little distance internal to the lateral border of the thickened area.

The female pores may be indicated by a pair of tiny white thickenings just in front of, and internal to setae a on segment xiv.

The spermathecal pores were not seen externally. There is some thickening ventrally on segments viii and ix, indefinite, and perhaps more specially marked round the site of the ventral setal couple.

Internal Anatomy.—Septum 4/5 is somewhat strengthened, 5/6–7/8 are thin, 8/9 is somewhat strengthened, 9/10 slightly so, the rest thin.

The two gizzards are relatively large, in segments v and vi. The calciferous glands, three pairs, in segments x, xi, and xii, are not set off from the oesophagus. The intestine begins in xiv (?).

The last heart is apparently in xii.

The micronephridia are arranged in four longitudinal rows on each side of the body; they are small twisted tubes, those of the innermost series on each side the smallest, and situated near the next outer row.

Testes and funnels are apparently free in segments x and xi (judged from the masses of free flocculent material in these segments). Seminal vesicles are present in segment xii only, as considerable masses with lobate margins.

The prostates are two pairs of relatively moderate size, twisted tubes lying in segments xvii and xix.

The spermathecae are two pairs, in segments viii and ix, ending apparently on the body-wall between the site of setae *a* and *b*. The ampulla is ovoid, rather elongated and with a somewhat pointed blind end, the duct as long as the ampulla, but not distinctly marked off, a little wider above. The diverticulum is single, shortly finger-shaped, one-third as long as the ampulla, to the lower end of which it is attached.

The penial setae are remarkable. In length they measure up to 2 mm.; but notwithstanding this they and their sacs were quite invisible in the dissection, and the prostatic duct was pulled out and mounted merely on the chance of getting something (the setal sacs are practically always identifiable, and can usually be isolated and removed separately; but in some cases, such as the small *Dichogasters*, the only practicable way is to remove prostates and setal sacs together). The setae are very slender, $5\text{--}6\mu$ in thickness, diminishing to 4.5μ near the tip. In shape they are undulating; there is no ornamentation, but where the tip is best seen it appears bifid, with a thin transparent web between the prongs of the fork; the base of the expanded portion is 9μ , and the length of the triangular web 18μ (fig. 52).

The copulatory setae of the spermathecal region are .42 mm. in length, and 13μ thick in the middle. The shaft is almost straight, with a bend at the proximal end however; the tip is slightly claw-shaped and bluntly pointed. The ornamentation consists of short transverse ridges on the distal part of the shaft (fig. 53).

Eudichogaster prashadi, sp. nov.

Plate XI, fig. 54.

Palia, between Indore and Ujjain. 27-vi-1917. B. Prashad. Several specimens, only two with sexual marks.

Indore, Central India. 23-vi-1917. B. Prashad. A single specimen.

Mhow Cant., Central India. 23-vi-1917. B. Prashad. A single specimen.

Khandwa, Central Provinces. 23-vi-1917. B. Prashad. Several specimens.

Bheraghat, Marble Rocks, 13 miles from Jubbulpore. 22-vi-1917. B. Prashad. Several specimens.

Teor, 8 miles from Jubbulpore, Central Provinces. 22-vi-1917. B. Prashad. Several specimens, mostly immature.

Saugor, Central Provinces. 20-vi-1917. B. Prashad. Numerous specimens.

Surat, W. India. 8-vii-1917. B. Prashad. Several specimens.

Poona, W. India; on the banks of the Rivers Mula and Mutta. 3-vii-1917. B. Prashad. Four specimens, only one showing distinct signs of maturity.

External Characters:—Length 35-67 mm., diameter 3-4.5 mm. Colour yellowish brown, with only slight difference between dorsal and ventral surfaces; the first few segments lighter. Segments 140-168.

Prostomium prolobous; there may be a mid-dorsal groove on the first segment, sometimes with an irregular course.

Dorsal pores from furrow 11/12 or 12/13.

The setal intervals vary somewhat; ab may be anything from $\frac{1}{5}$ to $\frac{1}{3}$ of aa , and over the greater part of the body=about $\frac{2}{5} bc$ and $\frac{3}{4} cd$; in front of the male apertures bc becomes rather smaller, and cd increases; the interval ab is smallest immediately behind the male field. The mid-dorsal interval dd is about $\frac{2}{3}$ of the circumference. Towards the anterior end the setae are difficult to see.

I never saw a distinguishable clitellum.

The appearances of the male field are also not very definite, but such as they are, they are pretty constant. The chief feature is the existence on each of the segments xvii and xix of a pair of ill-defined papillae, perhaps better described as whitish thickenings of the body-wall; these are generally transverse in direction, and have their centres somewhere near the line b , extending inwards and outwards to a variable extent; their limits are rather indistinct. On segment xviii there is usually a similar thickening which unites the outer parts of the thickenings on xvii and xix, thus making a crescentic swelling with its concavity inwards on each side (fig. 54a).

The prostatic pores are in or just internal to the line of setae b , on segments xvii and xix; the seminal grooves bend inwards slightly at the middle of their length, somewhat as in *E. ashworthi*. I saw the pores of the vasa deferentia in one specimen, on xviii in b , at the apex of the inward bend in the course of the seminal grooves; their anterior and posterior lips were slightly tumid.

The female pore or pores are perhaps contained within a minute white spot mid-ventral and anteriorly situated on xiv.

There are small transversely elongated white cushions on segments viii and ix, in the position of the ventral setal bundle. From internal dissection the spermathecae appear to discharge between the sites of setae a and b on these segments.

Internal Anatomy:—Septum 4/5 is thin; 5/6 to 9/10 are moderately strengthened, 10/11 slightly so, 11/12 still less, and the rest are thin.

The gizzards, large, rounded, and firm, are in segments v and vi; they are separated by a soft-walled part of the oesophagus in the anterior part of segment vi. The calciferous glands, in segments xi and xii, are shortly ovoid, and joined to the gut by a short stalk on the inner side. The intestine begins in xv.

The last heart is in segment xii.

Behind the genital region the micronephridia are in a transverse row on each side of each segment, and so arranged that the corresponding organs follow behind each other in longitudinal rows; of these there are about five on each side of the body. Towards the hinder end of the body the innermost nephridium of each transverse row on each side,—that by the side of the ventral nerve cord,—increases in size and thickness, and though still small is much the most conspicuous; the others of the row become individually smaller and increase in number, and lose the regularity of the arrangement in longitudinal rows.

Testes and funnels are free in segments x and xi; those in the two segments are equal in size. Seminal vesicles are present in segments ix and xii; in one specimen

dissected I found them only in xii, perhaps because the specimen was not fully mature.

The prostates are two pairs, in xvii and xix, small thin convoluted tubes with a generally transverse direction. The ducts are of the same diameter as the glandular part, but a little more shiny in appearance; they lie transversely.

The spermathecae are two pairs, in segments viii and ix; the ampulla is an elongated ovoid sac, and the duct cylindrical and as long as the ampulla. There is a single diverticulum, ovoid, not apparently containing any seminal chambers, attached by a short thick stalk to the base of the ampulla; it is bound down to the duct and base of the ampulla by connective tissue.

There are no penial setae.

The copulatory setae of the spermathecal region are not unlike those of *E. ashworthi*; they seem to be always present. In length they measure .47 mm., and are 16μ thick in the middle; they are almost straight, slightly bowed towards the distal end; the thickness does not diminish much till close to the tip, which is pointed and rather claw-shaped. The distal fifth of the shaft is marked by a number of large hollows scooped out of the shaft, each with a sharply defined and prominent proximal border, crescentic with the concavity towards the tip; the distal margin of each excavation slopes gently, and is not well marked (fig. 54b).

Remarks:—It is curious that the period of sexual maturity in some of these worms is so restricted,—that is if the presence of a clitellum is to be taken as a sign of complete maturity.

The present form has much in common with *E. indica* (Beddard). The latter however appears to be distinguished by the great separation of the lateral setae ($cd=2\frac{1}{2}ab$), by median genital papillae behind the spermathecal region, and by possessing only one pair of seminal vesicles.

Eudichogaster falcifer, sp. nov.

Plate XI, fig. 55.

Jubbulpore, Central Provinces. 22-vi-1917. B. Prashad. A number of specimens.

Bheraghat, Marble Rocks, 13 miles from Jubbulpore. 22-vi-1917. B. Prashad. A number of specimens.

Saugor, Central Provinces. 20-vi-1917. B. Prashad. A single specimen.

External Characters:—Length 40 mm.; thickness 2 mm. Colour a nondescript yellowish grey, no difference between dorsal and ventral surfaces, the anterior end lighter. Segments 128.

Prostomium proepilobous.

Dorsal pores from furrow 12/13.

The setal intervals may be expressed as follows:— ab in the middle of the body is rather greater than $\frac{1}{2}bc$ but rather less than $\frac{1}{2}aa$, and is nearly equal to cd ; behind the genital region ab is about equal to $\frac{1}{2}aa$ and to $\frac{1}{2}bc$, though aa seems just a little larger than bc ; in front of the genital region $ab = \frac{3}{5}aa = \frac{3}{5}bc = \frac{3}{4}cd$; dd is about $\frac{3}{5}$ of the circumference.

The clitellum was indistinguishable.

The male field is represented by a very slight whitening and thickening of the ventral surface of segments xvii to xix. The lateral parts of this area are better marked, and constitute definite ridges, which turning inwards at their anterior and posterior ends enclose the centre of the area as within brackets; in the longitudinal portion of their course the ridges lie a little outside the line *b*.

The seminal grooves are crescentic, the convexity outwards; they begin and end in the position of seta *a* on xvii and xix, and the prostatic apertures are presumably situated at these points; the grooves by their outward curve just get outside the line of setae *b* at the middle of their length.

The female pores were not visible.

There was nothing to be seen in the spermathecal region.

Internal Anatomy:—I could not distinguish any septa in front of 6/7, which is thin; 7/8 is thin, 8/9 to 10/11 slightly thickened, the rest thin.

There are two large gizzards in segments vi and vii. The calciferous glands are three pairs, roundly ovoid masses in segments x, xi, and xii. The intestine begins in xv.

The last heart is in segment xii.

Funnels were identified, perhaps somewhat doubtfully, lying free in segments x and xi. The seminal vesicles are two pairs, in ix and xii, yellowish in colour, of moderate size, somewhat lobulated and rather granular-looking on the surface.

The prostates were scarcely developed.

The spermathecae are two pairs, the ampulla of each a small ovoid sac which narrows ectally to become the duct; the duct may be said to be half as long and half as wide as the ampulla. A simple finger-shaped diverticulum, half as long as the ampulla, arises from the junction of ampulla and duct.

The penial setae are characteristic; their length is .3 mm., their thickness 8/9. The distal portion shows a gentle sickle-shaped curve, the tip being slightly bent in the opposite direction and bluntly pointed. There may be a constriction where the curved distal meets the straight proximal portion of the shaft. Towards the tip are a number of indentations of the margins, which however do not form spines standing off from the shaft (fig. 55).

***Eudichogaster pusillus*, sp. nov.**

Plate XI, figs. 56, 57.

Saugor, Central Provinces. 20 vi-1917. B. Prashad. A single specimen, damaged some distance behind the clitellum

External Characters:—Length 28 mm.; diameter maximum 1.5 mm. Colour greyish, not distinctive; clitellum a reddish-brown. Segments ca. 110.

Prostomium proepilobous.

Dorsal pores not seen in front of clitellum.

The setal relations are as follows:—In the middle of the body $ab = \text{half } aa =$

$\frac{2}{3}bc = \frac{3}{4}cd$ or almost so,—there is very little difference between bc and cd ; immediately behind the clitellum the ratios may be expressed in the same way; in front of the clitellum bc and cd are quite equal, —i.e. the lateral setae are not paired ($ab = \text{half } aa = \frac{2}{3}bc = \frac{2}{3}cd$).

The clitellum is well defined, swollen, smooth, and includes segments xiii-xvi ventrally, with xvii in addition laterally and dorsally (= 4 or 5).

The prostatic pores, on xvii, are a single pair of transverse slits which take up the interval ab .

The female pores are probably contained in a whitish area situated anteriorly on segment xiv; this is somewhat oval, with its long axis transverse and extending between the lines aa ; it is slightly hollowed.

The spermathecal pores could not be distinguished externally.

Internal Anatomy :—Septa 7/8-13/14 are slightly thickened.

There are two relatively very large gizzards, probably in segments v and vi, perhaps in vi and vii. There are three pairs of calciferous glands, in segments x, xi, and xii; they are ovoid, and not sharply set off from the oesophagus; those in x are the largest, those in xi the smallest. The intestine begins in xv.

The last hearts are in segment xii.

The excretory system is micronephridial.

Funnels were doubtfully identified in segments x and xi; the worm is of small size, and had possibly passed its period of maturity. A single seminal vesicle was found, on the right side in segment ix; none were seen in xii or elsewhere.

The prostates are one pair, short tubes in segment xvii, bent once or twice. The duct is much narrower than the glandular part,—is indeed very fine, but widens gradually towards its ectal end; it is opaque white in colour, not shining, almost as long as the gland, and runs transversely inwards.

A pair of relatively very large ovaries were found in xiii; the ova were seen as large opaque white bodies, arranged in a fern-like manner. The funnels were also of large size. A pair of ovisacs projected backwards from septum 13/14 into segment xiv; they contained large ova.

The single pair of spermathecae are contained in segment vii, and appear to open in or near furrow 7/8. Their appearance is peculiar (fig. 56); each is a long narrow twisted cylindrical tube, somewhat wider at its ectal end, where a short muscular duct,—only a fraction of the length of the ampulla, and about one-third as wide,—leads to the exterior. There is no diverticulum. The whole organ looks at first sight remarkably like a nephridium.

The penial setae (fig. 57) are relatively long compared with their thickness; they measure .56 mm., and are only 4μ thick in the middle. The shaft is almost straight, or at any rate is not regularly curved; it tapers very gently towards the tip, which is flattened and slightly expanded.

Remarks :—This form seems to resemble *E. parvus* (Fedarb), but is to be distinguished by the presence of penial setae and the position of the calciferous glands and seminal vesicles.

Eudichogaster kinneari, sp. nov.

(Plate XI, figs. 58, 59.)

Nasik, 100 miles N.E. of Bombay, W. India. 22-ix-1914. N. B. Kinnear. A number of specimens.

External Characters.:—The length of a fair-sized specimen is 80 mm.; the diameter behind the clitellum is 3.5 mm., while the bulbous anterior end is about 5 mm. thick at the sixth segment. Colour buff, no difference between dorsal and ventral surfaces, the clitellum brown. Segments of a fair-sized specimen about 120; segments iv-vi are biannular, vii and viii quadriannular, ix and subsequent segments up to the clitellum triannular with secondary subdivisions; triannulation again becomes marked towards the hinder end of the body.

The prostomium is small, prolobous, and withdrawn into the buccal cavity; the first segment is small, and it is divided by a mid-dorsal longitudinal groove,—a well marked and constant character.

The first dorsal pore is at the anterior border of the clitellum, in furrow 12/13.

Behind the clitellum, and in the body generally, the setal ratios may be expressed thus:— $ab = \frac{1}{4}$ to $\frac{1}{3}$ $aa = \frac{1}{3}$ to $\frac{1}{2}$ $bc = \frac{3}{4}$ cd ; ab is not very regular however. In front of the clitellum bc diminishes very considerably; anteriorly it becomes less than half aa and only about $1\frac{1}{2}$ times ab , and only slightly greater than cd ; the ventral couples are still widely separated from each other. The mid-dorsal interval dd is about $\frac{5}{8}$ of the circumference.

The clitellum is extremely well marked; it is brown in colour, swollen, and extends over segments xiii-xvi (= 4); it is deficient in a **V**-shaped interval ventrally on xiii. Dorsal pores and indications of furrows are visible, but not setae.

The male field is rectangular, its transverse extent greater than the longitudinal (fig. 58); it includes segments xvii-xix. The margins, especially the lateral, are much thickened; from the anterior and posterior two tongues project, backwards and forwards respectively, into the central depressed space, so that this becomes **H**-shaped. The floor of the **H**-shaped depression is deeply fissured; in it two pairs of papillae, one pair in each of segments xvii and xix, in the four corners of the **H**, represent the prostatic apertures. The seminal grooves are not always distinguishable among the numerous fissures of this region; they are like those of *E. ashworthi* and *E. prashadi*, with an inward bend at the middle of their course, thus $\left(\begin{array}{c} \text{ } \\ \text{ } \end{array} \right)$.

The female pores appear to be situated in a broadly spindle-shaped whitish area, which shows up markedly against the brown of the clitellum, anteriorly and mid-ventrally on segment xiv.

The spermathecal apertures are on the anterior part of the second annulus of segments viii and ix, in the line of a . Each is in the centre of a low squarish papilla, which takes up the greater part of the length of the segment.

There are numerous other papillae both in the region of the male field and also near the spermathecal pores. Almost constant are two pairs, with clean cut edges,

one on the posterior part of xvi, the other taking up most of the length of xx; these extend from about, or within, the line *a* to the lateral margin of the body; they are transversely oval in shape, and slightly depressed in the middle; the anterior pair may be narrower from front to back than the posterior. In a number of cases there are also median papillae, circular in outline, on one or both of these segments (xvi and xx). In the spermathecal region other papillae are usually found to the outer side of and touching those already described on segments viii and ix; these are circular, and include the lateral setal bundles; there may even be two such papillae on one side. Median papillae are often found in this region also, on the anterior part of segments x, xi and (once) xii.

Internal Anatomy:—Septum 4/5 is thin, 5/6-11/12 are moderately strengthened, the rest thin.

The gizzards, in segments v and vi, are large, firm, and globular. The calciferous glands are two pairs, in segments xi and xii; they are small, ovoid, well set off from the gut, and with smooth surface, not lobed. The canal swells out to form the intestine in xv, but is much narrowed again as it passes between the bulky prostates.

The last hearts are in segment xii. There is a pair of large oblique vessels in xiii, but these do not join the dorsal vessel as do the hearts,—certainly not at the usual place, the hinder border of the segment.

The micronephridia are scattered in the anterior segments. Behind segment x they are arranged in regular transverse rows; behind the prostates there are about six on each side of each segment; of these the more dorsal are in regular longitudinal rows, while the two most ventrally situated are closer together and not so regular. Towards the hinder end of the animal the innermost on each side in each segment becomes much thickened and more opaque, and thus, though it takes up no more space transversely, it is much more conspicuous than the rest. The other five maintain their number and regularity however to within a very few segments of the end.

Testes and funnels, the latter of large size, are free in segments x and xi. Seminal vesicles are present in segments ix and xii; those in ix are small, those in xii much larger, lobed, and bulging back septum 12/13.

The prostates are large, the anterior pair extending over xviii and xix, or xvii, xviii, and xix and even getting into xx; the posterior pair occupies xx and xxi; thus they overlap. The glandular part consists of closely adpressed coils. The duct is much thinner, though rather wider as it approaches its termination; it is shining, and thrown into one or two loops. Each duct leads forwards to end in the usual situation.

The spermathecae are two pairs, in segments viii and ix. The ampulla is ovoid, of moderately large size, and shows slight annulation; the duct is well marked off from the ampulla, and is half as long and two-fifths as thick as the latter; it narrows towards its ectal end. The diverticulum is single, and consists of a large number of minute seminal chambers, the whole attached by a short thick stalk to the ental end of the duct (fig. 59).

Penial setae are absent.

The copulatory setae of the spermathecal region are in their ornamentation exactly similar to those of *E. prashadi*, and no separate figure is needed. In length they measured from .73 to .87 mm., in thickness 25μ at the middle; and the extent of the shaft occupied by the sculpturings is about one-third of its length. It is noteworthy that whereas in most cases it is the ventral setae of segments viii and ix which are modified, here the lateral setae, included in the lateral papillae on these segments, may also develop as "copulatory setae."

Genus **Dichogaster**.

Dichogaster bolaui (Mehlsn.).

Bombay. June 1915. N. B. Kinnear. Several specimens.

Bassein Road, N. of Bombay, W. India. 7-vii-1917. B. Prashad. Four specimens.

Baroda, W. India. 9-vii-1917. B. Prashad. Two specimens. -

Bayana, 20 miles S.W. of Bharatpur, E. Rajputana. 15-vii-1917. B. Prashad. A single specimen.

var. **malabaricus**, var. nov.

Bombay; under a tree near the Fort. 30-vi-1917. B. Prashad. A single specimen.

External Characters:—Length 31 mm.; diameter 2.25 mm. Colour buff, unpigmented except for a dark mid-dorsal stripe. Segments 86.

Prostomium prolobous.

A conspicuous dorsal pore is seen in furrow 5/6, and then no more till 11/12, where there is a rudimentary one. The pores are well marked from 12/13 onwards.

In the middle of the body the setal relations are as follows:— $ab = \frac{1}{4}aa = \frac{1}{4}bc = cd$; and they are about the same in the region behind the clitellum; in front of the clitellum all the pairs are closer together, more distinctly ventral, and dd , which behind is about $\frac{4}{7}$ of the circumference, consequently increases.

The clitellum extends over xiii-xx (=8); dorsally it almost covers xxi in addition. It is ring-shaped over xiii, a little thinner ventrally in xiv, xv, and xvi and thenceforward interrupted ventrally. The region is swollen, and well defined at each end.

The seminal grooves run in the interval ab ; they are straight, and bordered by whitish thickened lips; the inner lips of the grooves are almost contiguous in the middle line.

The spermathecal apertures were not visible. The ventral surface of segment viii, and perhaps of ix, appears slightly thickened, and the setae rather displaced and irregularly set.

Internal Anatomy:—Septum 4/5 is slightly strengthened; if 5/6 and 6/7 are present, they are not discernible in this specimen (which is not in very good preservation); 7/8 is thin, 8/9 and 9/10 perhaps slightly thickened, the rest thin.

The gizzards are in segments vii and viii, and the alimentary tube is scarcely constricted between them. The calciferous glands are kidney-shaped, with the hilus turned inwards, and occupy segments xv, xvi, and xvii. The intestine begins in xviii.

The last heart is in xii.

The testes and funnels were not identified in segment x, but they seemed to be present in xi. There were very small racemose seminal vesicles in segment xii.

The ovaries had the usual situation; there were small ovisacs in segment xiv.

The prostates and two kinds of penial setae are as for the typical form. The spermathecae however present one of the peculiar features which distinguish this worm as a separate variety; there are two diverticula, small, sessile, attached about the middle of the duct.

Remarks :—The two spermathecal diverticula, and the fact that the clitellum is not saddle-shaped throughout its extent, seem to warrant the separation of this form as a distinct variety.

Dichogaster affinis (Mchlsn.).

Baroda, W. India, in a garden. 10-vii-1917. B. Prashad. Two specimens.

Bombay, under a tree near the Fort. 30-vi-1917. B. Prashad. A single specimen.

Bombay, Elephanta Island, in a rotten tree. 30-vi-1917. B. Prashad. Four specimens.

Dichogaster crawi, Eisen.

Pashok, 3500 ft., Darjiling Dist., E. Himalayas. 1-12-x-1917. F. H. Gravely. A single specimen.

Remarks :—This species has not hitherto been recorded from India; it was described by Eisen from the Pacific Coast of N. America, and its occurrence in India may thus be compared with that of *D. bolawi* subsp. *palmicola* (12).

Subfam. *OCNERODRILINAE*.

Genus **O c n e r o d r i l u s**.

Ocnerodrilus (Ocnerodrilus) occidentalis, Eisen.

Bombay. June 1915. N. B. Kinnear. A number of specimens.

Kotah, Rajputana. 14-vii-1917. B. Prashad. A number of specimens.

The specimens of the batch from Kotah show some of the characters of Eisen's var. *arizonae*. I have previously on a similar occasion (9) had the opportunity of confirming Michaelsen's opinion of the non-validity of this variety.

Fam. *GLOSSOSCOLECIDAE*

Subfam. *GLOSSOSCOLECINAE*.

Genus **P o n t o s c o l e x**.

Pontoscolex corethrurus (Fr. Müll.).

Bombay. June 1915. N. B. Kinnear. Two specimens, immature.

Poona, W. India, Empress Gardens. 3-vii-1917. B. Prashad. Seventeen specimens, some immature.

Subfam. *MICROCHAETINAE*.

Genus **G l y p h i d r i l u s**.

Glyphidrilus papillatus (Rosa):

Lucknow. 15-i-1918. G. S. Thapar. A number of specimens

The worm has been described by Rosa from Burma, from a single specimen which was not in very good condition, and not fully mature. As I have had a considerable number of examples, carefully preserved by Mr. Thapar, to whom my thanks are due for these interesting specimens, I give below a fairly complete description.

External Characters :—Length 120 mm.; diameter at and in front of the clitellar region 3 mm., behind the clitellum 2 mm. Colour flesh-colour or greyish, no distinct pigmentation; a slightly darker mid-dorsal stripe. The posterior half of the body is flattened on the dorsal side, and even concave in the hinder third; the ventral surface is flattened or slightly concave for the greater part of its extent. Segments 202 in the example which was counted. Segment vi is biannulate, vii is triannular, and so are viii and ix, but these may be further subdivided; the succeeding segments as far as xv are bi- or triannulate. The anterior end of the body is tapering; the posterior end becomes gradually thinner also.

The prostomium is large, zygalobous, and triangular. Dorsal pores are absent.

The setae are paired; behind the clitellum, the section of the body being somewhat quadrangular, the couples are at the four angles; ab is a little less than half aa , is equal to half bc , and is equal to cd ; dd is a little but not much greater than aa . The setae become very small in front of the clitellum, and also wider apart. In the posterior part of the body the setae are still at the angles, but the intervals are rather different; dd becomes larger and bc smaller; $ab = \frac{2}{3}aa = \text{half } bc = cd = \frac{2}{7}dd$.

Under close examination the anterior segments showed rings of minute pits; these were on the middle annulus where the segments were multiannular; possibly they represent sense organs.

The clitellum is rather indefinite in its extent; beginning at segment xvi it extends back to xxvi-xxxiv. The wing-like ridges extend ventro-laterally along each side from segment xviii to xxiii, xxiv, xxv, or the anterior part of xxvi; they arise from the body-wall outside the line of the ventral setal couples.

The characteristic papillae are large, round, flattened or slightly depressed in the middle, and situated on the posterior parts of the segments. They are lateral or median; the former series occur in line with or slightly dorsal to the attachment of the winglike folds of the body-wall, are usually paired, and may be found on any of the segments x-xvii, as well as occasionally on xxiii, xxv, or xxvi; they are commonest on xiii-xvii, especially xv-xvii. The median papillae are not so common as the lateral; I have found them only on xi-xv, and xvii and xviii. Median papillae may be absent altogether; the lateral papillae may be as few as two pairs, or two on one side and one only on the other.

Internal Anatomy :—The first definite septum is $4/5$, which is thin; $5/6$ is slightly, $6/7$ - $9/10$ moderately, and a few succeeding ones slightly thickened.

The gizzard is in segments vii and viii; septum $7/8$ is adherent to it at about its middle, but there is no constriction there; it is rather small, being no wider than the preceding segments, and is fairly soft. The intestine begins in segment xvi.

Hearts are present in segments x and xi, and, in the specimen dissected, on the right side in ix also.

There was much flocculent matter in segments x and xi, and much of it was tenacious and iridescent, seeming to indicate the presence of seminal funnels; but neither testes nor funnels were actually identified. The seminal vesicles are four pairs, but they are not always symmetrical in each segment; thus in ix there was a large one on the right, a small one on the left, while in x the condition was the opposite; in xi there was a separate round lobe on the left side in addition to the normal vesicle. The vesicles are usually deeply lobed.

There were no prostates.

The ovaries have the usual situation. I can confirm the presence of ovisacs in xiv; there appears to be a pair of exactly similar structures in xv.

The spermathecae, which were not present in Rosa's specimen, are in four series on each side, each series consisting of a transverse row of five, opening in furrows 13/14-16/17. In addition there was a single one on the right side opening in 12/13. Each spermatheca is a small ovoid or irregularly elongated saccule, its blind end directed backwards, and the whole adherent to the body-wall. The position of the five organs on each side is thus:—one in each of the lines *a*, *b*, *c*, and *d*, and one between *b* and *c*.

Fam. LUMBRICIDAE.

Genus *Helodrilus*.

Helodrilus caliginosus (Sav.) var. *trapezoides* (Ant. Dug.).

Mount Abu, S. Rajputana. Col. J. Manners-Smith. March 1918. Very numerous specimens.

Nasratabad, Seistan, E Persia, from a garden. 25-xi-1918. N. Annandale and S. W. Kemp

A number of specimens.

Helodrilus parvus (Eisen).

Partabgarh, S. Rajputana. Feb. 1918. Col. J. Manners-Smith. A single specimen.

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EXPLANATION OF PLATE IX.

- FIG. 1.—*Nais paraguayensis*; needles of the dorsal bundles; *a*, with bifid outer prong; *b*, with bent inner prong.
- „ 2.—*Nais paraguayensis* var. *aequalis*; dorsal needle, \times *ca.* 1200.
- „ 3.—*Nais gwalioensis*; dorsal needle, \times *ca.* 1100.
- „ 4.—The same; ventral setae; *a*, of segments behind v; *b*, of segments ii-v; \times *ca.* 1100.
- „ 5.—*Megascolides prashadi*; male genital field.
- „ 6.—The same; spermatheca.
- „ 7.—*Perionyx sansibaricus*; region of male apertures.
- „ 8.—*Perionyx millardi*; spermathecae showing different characters of diverticula; *a*, specimen from Virar; *b*, from Talegaon; *c*, from Kalyan.
- „ 9.—*Perionyx rimatus*; spermatheca.
- „ 10.—*Perionyx pokhrianus*; male genital field.
- „ 11.—The same; spermatheca.
- „ 12.—*Perionyx pokhrianus* var. *affinis*; male genital field.
- „ 13.—The same; spermatheca.
- „ 14.—*Perionyx alatus*; male genital field.
- „ 15.—The same; spermatheca.
- „ 16.—The same; tip of penial seta, \times *ca.* 250.
- „ 17.—*Perionyx shillongensis*; spermatheca.
- „ 18.—*Perionyx fossus*; spermatheca.
- „ 19.—The same; tip of penial seta, \times *ca.* 400.



Fig. 1.



Fig. 2.



Fig. 3.

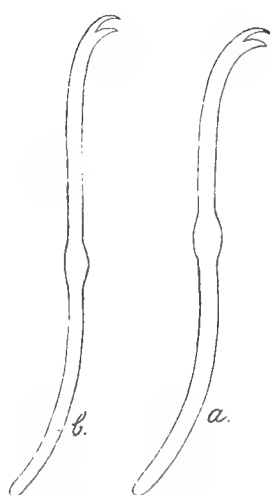


Fig. 4.

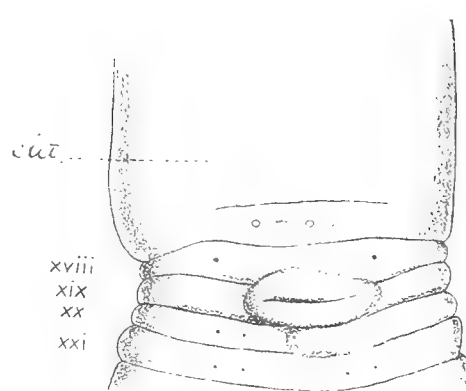


Fig. 5.



Fig. 6.

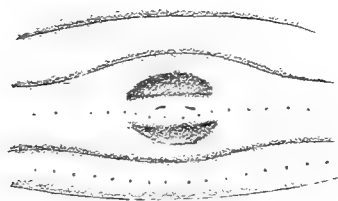


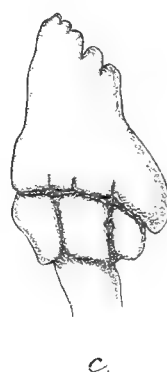
Fig. 7.



a.



b.



c.

Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.



Fig. 12.



Fig. 13.

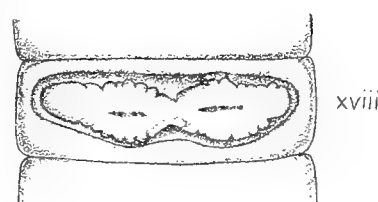


Fig. 14.

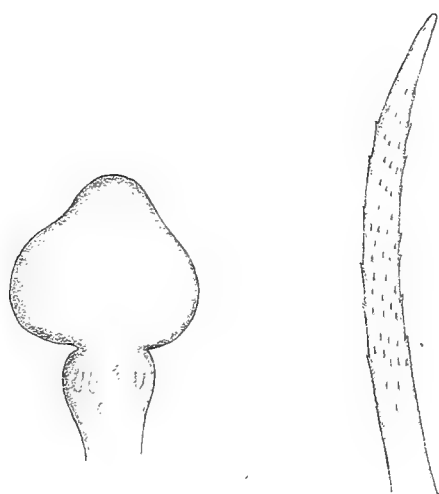


Fig. 15.



Fig. 16.



Fig. 17.



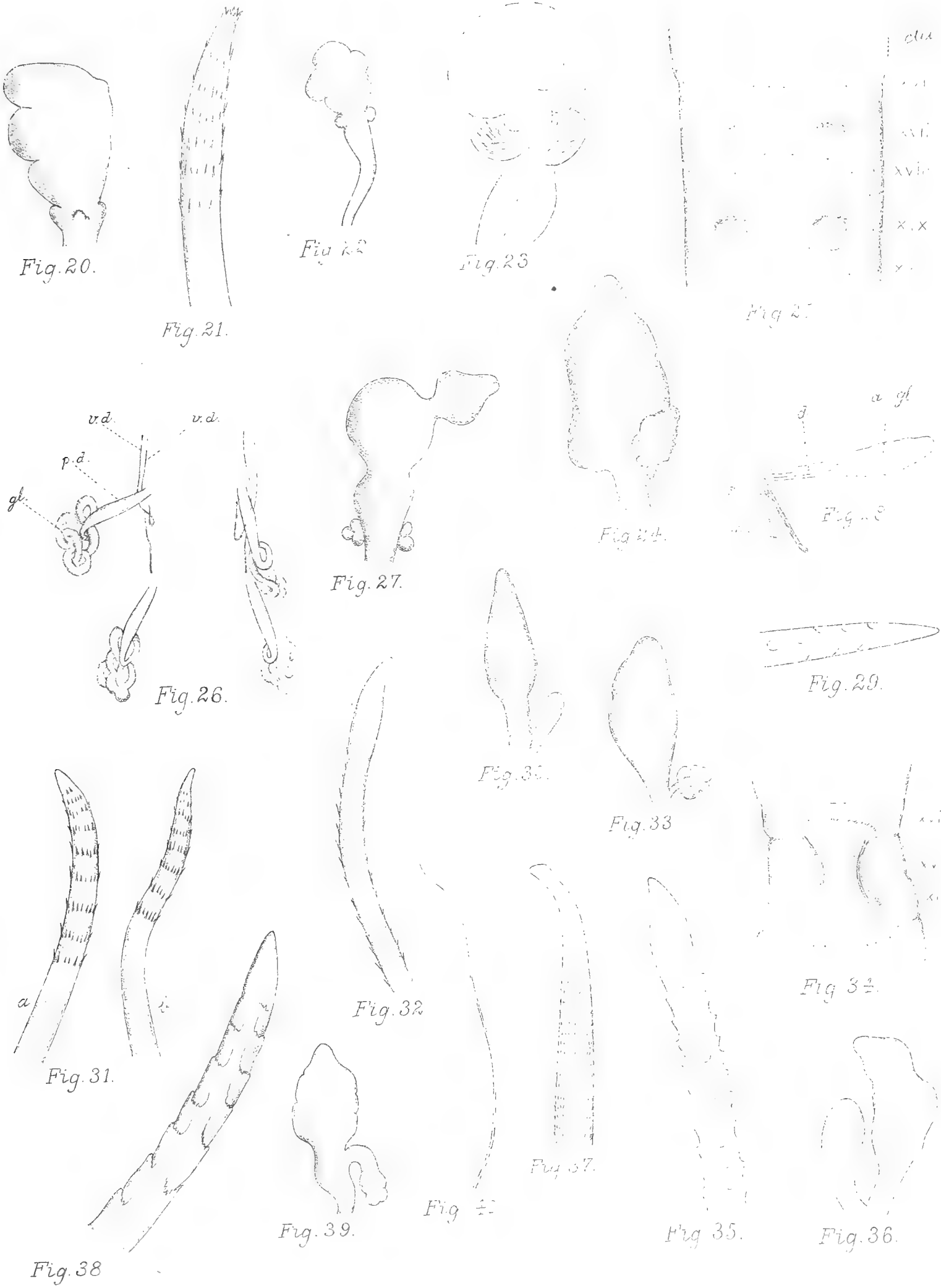
Fig. 18.



Fig. 19.

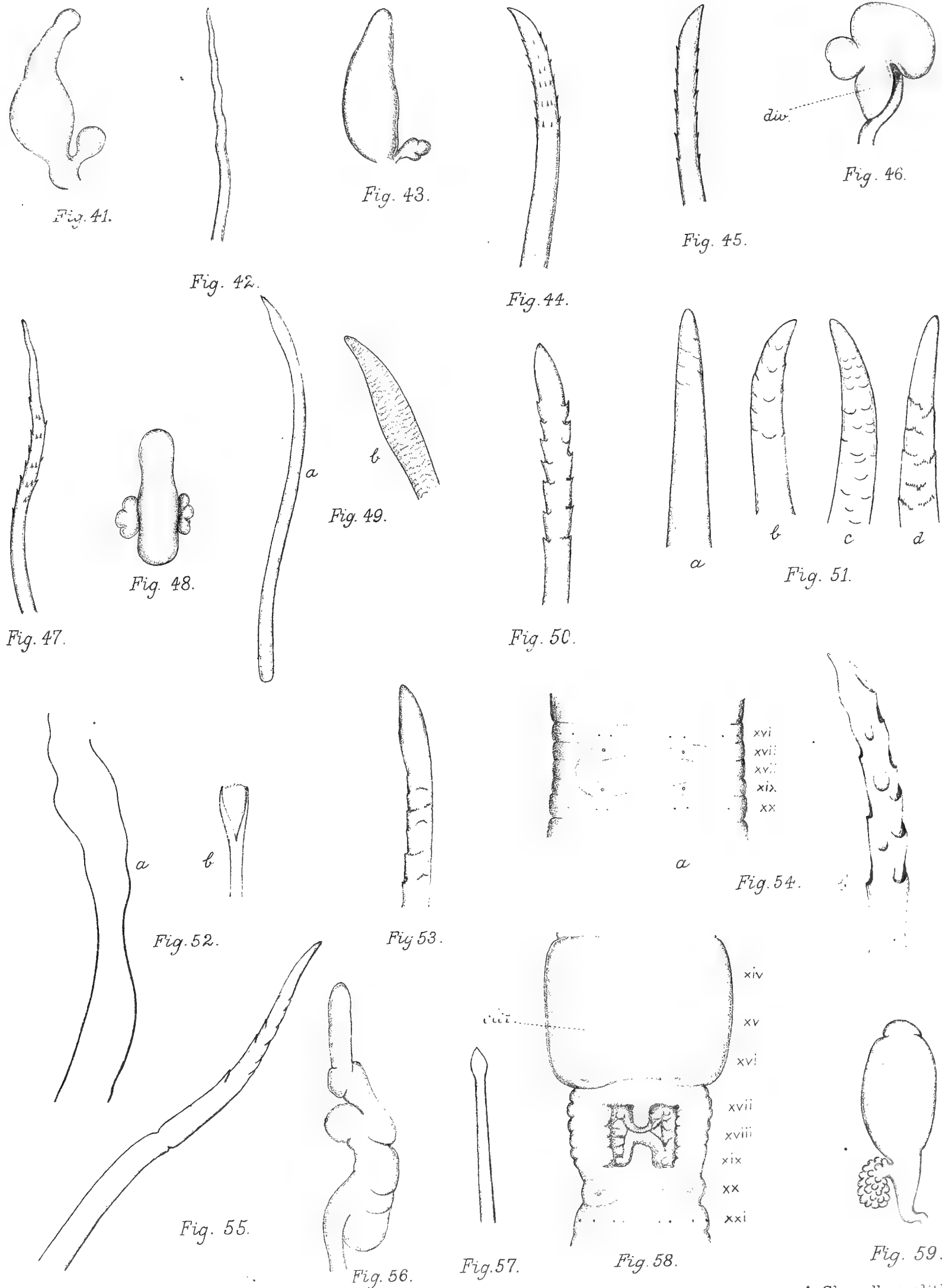
EXPLANATION OF PLATE X.

- FIG. 20.—*Perionyx turaensis* ; spermatheca, $\times 40$.
- „ 21.—The same ; tip of penial seta, $\times 700$.
- „ 22.—*Perionyx pullus* ; spermatheca.
- „ 23.—*Perionyx minimus* ; spermatheca as seen under the microscope.
- „ 24.—*Perionyx igatpuriensis* ; spermatheca.
- „ 25.—*Hoplochaetella anomala* ; male genital area.
- „ 26.—The same ; diagram showing relations of prostatic ducts and vasa deferentia. *Gl.*, prostatic gland (the coils are not intended to be shown with exactitude) ; *p.d.*, prostatic duct ; *v.d.*, the two vasa deferentia.
- „ 27.—The same ; spermatheca.
- „ 28.—The same ; sketch showing relations of accessory gland in neighbourhood of spermatheca and copulatory seta, extracted together and seen under microscope.
- „ 29.—The same ; tip of copulatory seta.
- „ 30.—*Octochaetus paliensis* ; spermatheca.
- „ 31.—The same ; penial setae, both from the same specimen as the above ; $\times ca.$ 340.
- „ 32.—The same ; copulatory seta, from same specimen as the above ; $\times ca.$ 230.
- „ 33.—The same ; spermatheca of specimen from Poona.
- „ 34.—*Octochaetus paliensis* var. *riparius* ; male genital region.
- „ 35.—The same ; copulatory seta, $\times ca.$ 350.
- „ 36.—*Octochaetus prashadi* ; spermatheca.
- „ 37.—The same ; tip of penial seta, $\times ca.$ 175.
- „ 38.—The same ; tip of copulatory seta, $\times 375$.
- „ 39.—*Octochaetus montanus* ; spermatheca.
- „ 40.—The same ; penial seta, $\times 40$.



EXPLANATION OF PLATE XI.

- FIG. 41.—*Octochaetus pallidus*; spermatheca.
 „ 42.—The same; tip of penial seta, $\times 600$.
 „ 43.—*Octochaetus ganeshae*; spermatheca.
 „ 44.—The same; tip of penial seta, $\times 600$.
 „ 45.—The same; tip of copulatory seta, $\times 500$.
 „ 46.—*Octochaetus pachpaharensis*; spermatheca; *div.*, diverticulum (?).
 „ 47.—The same; tip of penial seta, $\times ca. 300$.
 „ 48.—*Eutyphoeus turaensis*; spermatheca seen from above, as in dissection; the sac is attached to the body-wall by the middle of its under surface.
 „ 49.—The same; penial seta; *a*, seen as a whole, $\times ca. 55$; *b*, tip more highly magnified, $\times ca. 180$.
 „ 50.—*Eudichogaster ashworthi* (co-type); copulatory seta from spermathecal region.
 „ 51.—The same; copulatory setae of neighbourhood of prostatic apertures (not however from segments xvii or xix); *a*, from Wahi near Mahableshwar; *b*, from Poona; *c*, from Saugor; *d*, from Jubbulpore.
 „ 52.—*Eudichogaster trichochaetus*; penial setae; *a*, as a whole, $\times 37$; *b*, the tip, more highly magnified, $\times 550$.
 „ 53.—The same; end of copulatory seta; $\times ca. 400$.
 „ 54.—*Eudichogaster prashadi*; *a*, region of male genital apertures; *b*, end of copulatory seta, $\times 500$.
 „ 55.—*Eudichogaster falcifer*; distal end of penial seta, $\times ca. 700$.
 „ 56.—*Eudichogaster pusillus*; spermatheca.
 „ 57.—The same; tip of penial seta.
 „ 58.—*Eudichogaster kinneari*; clitellum and male genital area (the seminal grooves are not seen; the grooves shown are irregular fissures in the floor of the H-shaped depression).
 „ 59.—The same; spermatheca.



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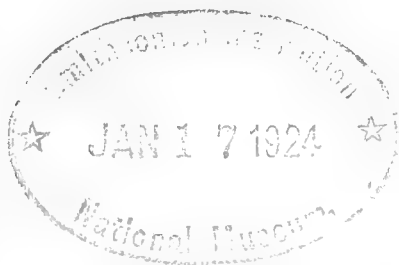
REPORT ON THE PARASITIC NEMATODES IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA.

BY

H. A. BAYLIS, M.A., D.Sc., *British Museum (Natural History)*

AND

R. DAUBNEY, M.Sc., M.R.C.V.S., *Ministry of Agriculture and Fisheries.*



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INTRODUCTION.

The following report deals with an extensive collection of nematodes kindly submitted to us for determination by Dr. N. Annandale, Director of the Zoological Survey of India. It comprises material belonging to the Indian Museum, Calcutta, and material, collected since August, 1916, belonging to the Zoological Survey. A

large proportion of this material was collected from animals, mostly Indian, in the Zoological Garden, Calcutta. This applies to the majority of the species for which no locality is given.

It is difficult to judge to what extent the range of hosts of a parasite may be affected by the presence of a number of suitable hosts in more or less close proximity under artificial conditions in a menagerie. It has been observed that wild animals tend to lose their original parasitic infections after a short time in captivity; but there are some indications in the present collection that a parasite hitherto only known to occur in one or two hosts may, under these conditions, have been enabled to extend its range to hosts with which it would not normally have come into contact. As instances we may mention particularly the cases of *Ascaris lumbricoides* and the various species of *Heterakis*, especially *H. longicaudata*; while it seems probable that the species of *Ancylostoma*, *Belascaris* and *Toxascaris* enjoy exceptional opportunities in this respect in a menagerie where many kinds of carnivores are kept near to each other. The lists of hosts that we have been able to compile for these forms seem to bear out this suggestion.

As regards the position of parasites in their hosts, there was a certain amount of vagueness in many of the original labels. Often the label indicated the "intestines," but this term appears to have been applied somewhat widely to include most of the abdominal and thoracic viscera, and on this account we have decided, in many cases, to omit any mention of the site of election. The species of *Heterakis* from birds, for example, are usually found in the caeca of their hosts, and to mention the "intestines" conveys no information of any value.

The present report deals mainly with nematodes from vertebrate hosts, although two forms found in invertebrates are described. The material submitted to us also included a number of Mermithidae, but we have not attempted as yet to deal with these, and have thought it advisable to publish without unnecessary delay the results of our work on the more strictly parasitic forms. These include members of nearly every superfamily, and, while the number of new species is not large, the collection is valuable for the light it throws on a number of imperfectly known forms, and for the general idea it furnishes of the parasitic nematode fauna of India.

Throughout the report the names used for the hosts, so far as Indian animals are concerned, are for the most part those given in the *Fauna of British India* (Mammalia, by W. T. Blanford, 1888—1891; Birds, Vols. I—II, by E. W. Oates, 1889—1890, and Vols. III—IV, by W. T. Blanford, 1895—1898; Reptilia and Batrachia, by G. A. Boulenger, 1890; Fishes, by F. Day, 1889). The names of hosts (other than domestic animals) which are not indigenous in the Indian Empire are marked with an asterisk (*).

Superfamily ASCAROIDEA, Railliet and Henry, 1915.

Family ASCARIDAE, Cobbold, 1864.

Subfamily ASCARINAE, Travassos, 1913. (Askarinae Raill. and Henry, 1912.)

Genus *Ascaris*, L., 1758.

Ascaris lumbricoides, L., 1758.

The collection contains material which we refer to this species from an interesting range of hosts :—

Man (European boy, Calcutta).

Orang Utan * (*Simia satyrus*).

Large Indian squirrel (*Sciurus indicus*).¹

Irrawaddy squirrel (*Sciurus pygerythrus*).²

“Squirrel.”

This species is, of course, known to be a parasite of the larger apes, as well as of man. It has long been a matter of opinion whether the form, often called *A. suum* or *A. suilla*, occurring in pigs, both domesticated and wild, is or is not a distinct species from *A. lumbricoides*. The discovery of what appear to be full-sized specimens of the human worm in squirrels is of great interest, especially when the relatively small size of these animals is taken into account. We have carefully examined and compared specimens from man, from an Indian wild pig, and from the above-mentioned squirrels, paying particular attention to the characters of the lips, of the male tail, and of the eggs, and our view is that all belong to the same species. The number and arrangement of the caudal papillae of the male have been well figured by Schneider (1866, p. 37). Quite characteristic is the presence of two pairs of large double papillae behind the cloaca, and three small simple papillae, arranged in a triangle, on either side posteriorly. There is also constantly a pair of double papillae at some little distance from the cloaca, in the preanal series, though the corresponding papillae of the two rows are usually very asymmetrical in position. A curious, large, median, papilla-like structure, or cushion, just in front of the cloaca, and the short, broad, dorso-ventrally flattened, non-alate spicules, somewhat enlarged in the distal half, are also characters common to all the material.

As regards the lips, little need be said except that no accurate account of the cephalic papillae appears to exist. The dorsal lip carries two large, lozenge-shaped papillae, with double terminations, near its lateral margins, while each ventro-lateral lip has (a) towards the ventral side a large, double papilla, and (b) towards the opposite side *two small, separate, simple papillae*. In the presence of these papillae, and in all other respects, the lips of individuals from man, pig and squirrel seem to us to agree.

The supposed differences between *A. lumbricoides* and “*A. suilla*” are based chiefly on size, the worms found in the pig being usually of slenderer build than those from man. E. Blanchard (1849)

¹ Now known as *Ratufa indica*. See Robinson and Kloss, *Rec. Ind. Mus.* XV, p. 186 (1918).

² Now known as *Tomeutes pygerythrus*; *loc. cit.*, p. 226.

also mentions differences in the relative lengths of parts of the female reproductive organs, but such differences may constantly be observed in female nematodes of different ages, of the same species and from the same host. In our opinion, the evidences of identity furnished by the structural characters mentioned are of much greater weight.

Recent experimental work by Stewart and others has shown that *A. lumbricoides* can reach a certain stage of development in the rat, mouse, guinea-pig and rabbit, but it has not yet been found to settle in the intestine and attain sexual maturity in these animals. The present record of the adult worm in squirrels (assuming, as we believe to be justifiable, that the species is the same), shows that the development may, under suitable conditions, be completed in a rodent.

Ascaris vitulorum, Goeze, 1782.

(Figs. 1—3.)

The distinctive characters of this form do not seem to be at all well known, and we are not aware of any recent description of it.¹ Ransom (1911) gives only the briefest details of its anatomy, and these seem to have been mainly quoted from Neumann. A few specimens taken from a calf at Siripur, Bihar, though in rather poor condition, enable us to add a few details to the description, and to correct others.

Our specimens measure from 85 mm. (male) up to 140 mm. (female) in length. The cuticle is marked with transverse rings at intervals of 0.03–0.075 mm. Finer striations, if present, were not seen.

The diameter of the head, at the base of the lips, is about 0.5 mm.; that of the neck, immediately behind the lips, 0.7 mm. The lips (fig. 1) are broad at the base and narrow in front. The dorsal lip carries a pair of large, simple papillae; each ventro-lateral lip a large, lozenge-shaped papilla towards the ventral side and a small, round papilla laterally and more anteriorly. The pulp of each lip sends out two rounded lobes anteriorly, and from the inner surface of each lobe a blunt, inwardly-directed process originates. The two processes converge slightly towards the middle line of the lip. Dentigerous ridges, with coarse teeth,

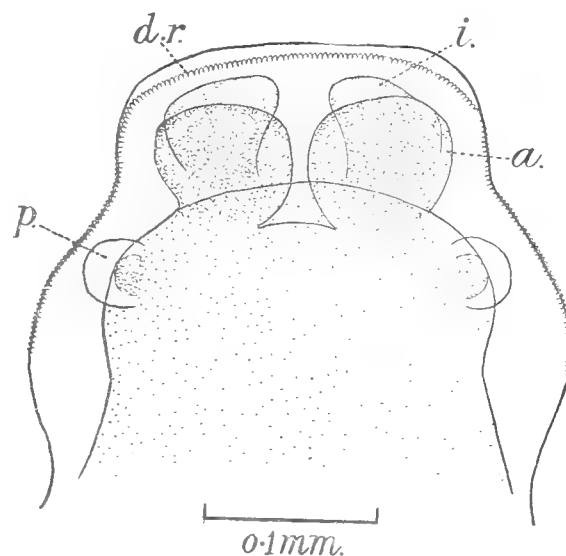


FIG. 1.—*Ascaris vitulorum*. Dorsal lip, viewed from exterior.

a., anterior lobe of pulp; *d.r.*, dentigerous ridge; *i.*, internal process of anterior lobe; *p.*, papilla.

are present. There are no interlabia. The oesophagus is modified posteriorly into a small, almost globular "ventriculus," or glandular bulb (fig. 2), measuring about 0.35 mm. long and 0.45 mm. wide. This is not distinctly constricted off from the muscular portion of the oesophagus, but is preceded by a slight narrowing of the latter. The entire oesophagus measures about 4 mm. in length. The nerve-ring surrounds it at about 0.8 mm. from the anterior extremity.

¹ Since this paper was prepared, a description has been published by Boulenger (*Parasitology* XIV, 1, 1922, p. 87), which agrees on the whole with ours, except that he appears to have seen more pairs of postanal papillae than we could detect in our material.

The tail of the male (fig. 3) measures 0.33 mm. in length. It is not, as is sometimes stated in text-books, without postanal papillae. On the contrary, it possesses three

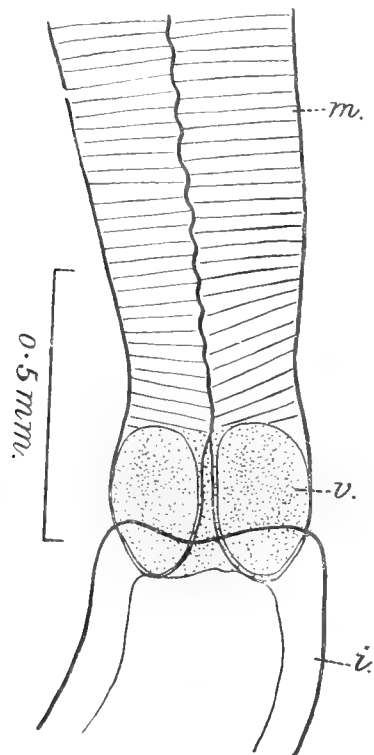


FIG. 2.—*Ascaris vitulorum*. Posterior portion of oesophagus and commencement of intestine.

i., intestine; *m.*, muscular portion of oesophagus; *v.*, ventriculus.

pairs on the ventral surface, of which the most anterior consists of very large, double papillae. There appear to be about nine pairs of preanal papillae. The spicules are stout, tubular and without alae. They were unfortunately broken in our specimens, and we are unable to give their length. Their diameter is about 0.043 mm.

The vulva is situated at about 17 mm. from the anterior end in a specimen mm. 125 long, thus dividing the body in the proportion of about 1:6. The vagina and the unpaired portion of the uterus run back, gradually widening, with a rather sinuous course, to a point about 11 mm. behind the vulva, before giving off the two parallel uterine branches. The coils of the ovarian tubes return towards the anterior end as far as the level of the vulva. The eggs are oval, and have a thick, coarsely granulated shell and an unsegmented content. They measure 0.075–0.09 × 0.06–0.07 mm.

Ascaris, sp.

A small immature female, from the intestine of a wild pig (*Sus bengalensis*), near Dinapore, Bihar. It is doubtful whether this can be assigned to *A. lumbricoides*.

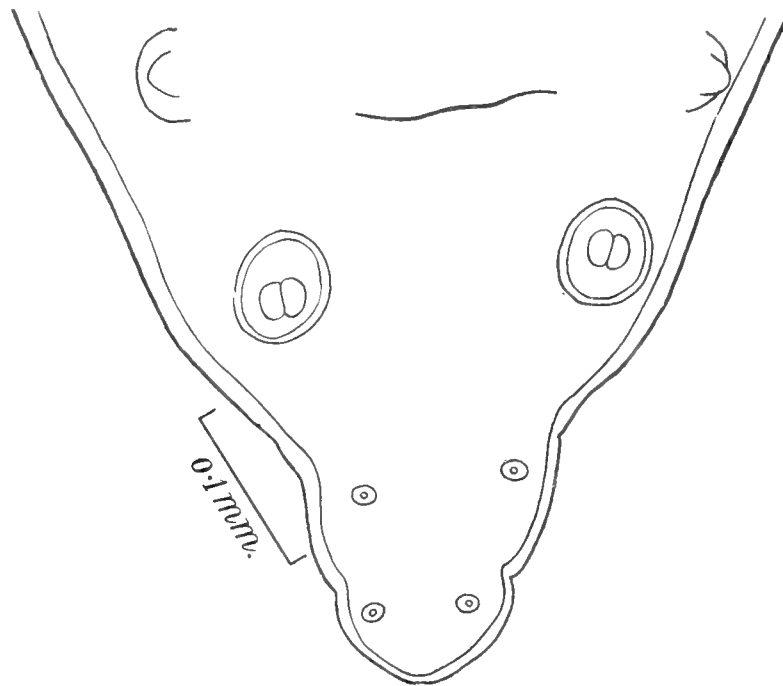


FIG. 3.—*Ascaris vitulorum*. Tail of male; ventral view.

Ascaris, sp. (?)

A single immature specimen, about 14 mm. in length, from *Varanus salvator*. We are unable to assign this definitely to any species.

Genus **Belascaris**, Leiper, 1907.

Belascaris mystax (Zeder, 1800).

This species occurs in the collection from the following hosts:—

Domestic cat.

Siamese domestic cat.

Tiger (*Felis tigris*).

Leopard (*Felis pardus*).

Jungle cat (*Felis chaus*).

Leopard cat (*Felis bengalensis*).

Fishing cat (*Felis viverrina*).

Belascaris marginata (Rud., 1802).

In addition to a single female of this species from a jackal and some doubtful specimens, in very poor condition, from an Indian wolf (*Canis pallipes*), the collection contains a number of Ascarids from the stomach and intestine of an Indian fox (*Vulpes bengalensis*). After comparison with material from the domesticated dog, we conclude that these worms from the fox belong to the same species (*B. marginata*). It may be mentioned in this connection that Riley (1921) states that this species frequently occurs in foxes farmed for commercial purposes in Canada and the United States. At the same time, the *Ascaris vulpis* of Frölich, 1789 (= *A. triquetra*, Schrank, 1790), was regarded by Railliet and Henry (1911) as a distinct species of *Belascaris*, although no satisfactory description of it appears to exist. The only distinctive features of this supposed species mentioned by Railliet and Henry are the greater development of the caudal alae, and the presence of a gutter-like depression of the ventral surface of the tail, in the male. These, as it seems to us, are appearances which might easily be the result of imperfect preservation or extreme contraction, and there appears to be no other ground for accepting *Belascaris vulpis* as a valid species.

It is appropriate in this place to refer to two other species recorded from more or less closely related hosts. *Belascaris masculior*, Railliet and Henry, 1911, from the Fennec fox (*Megalotis zerda*), appears to be a species of smaller average dimensions than *B. marginata*, but with somewhat longer spicules. There is nothing else in the description by which it can be differentiated.

B. melis, Gedoelst, 1920, from the badger, attains a very large size, though its spicules are not longer than those of *B. marginata*. According to Gedoelst's account, there are only three pairs of papillae on the terminal appendage of the tail in the male, instead of the five pairs usual in the genus, and the number of preanal papillae appears to be unusually large.

Genus **Toxascaris**, Leiper, 1907.

Toxascaris leonina (v. Linst., 1902).

This species occurred in the following hosts :—

Lion (*Felis leo*).

Tiger (*Felis tigris*).

Leopard (*Felis pardus*).

Ounce, or Snow leopard (*Felis uncia*).

Fishing cat (*Felis viverrina*).

Leopard cat (*Felis bengalensis*).

Hunting leopard (*Cynaelurus jubatus*).

(?) Indian fox (*Vulpes bengalensis*).¹

Toxascaris transfuga (Rud., 1819).

(Figs. 4, 5.)

The collection contains abundant Ascarid material from bears—the Himalayan black bear (*Ursus torquatus*) and the sloth-bear (*Melursus ursinus*)—and also from the red cat-bear (*Aelurus fulgens*), all of which we refer to *Ascaris transfuga* Rud. *Aelurus* appears to be a new host for this species. Examination of the material shows clearly that *A. transfuga* has all the essential characters of the genus *Toxascaris*, as defined by Leiper (1907) and by Railliet and Henry (1911).

The best description of the species at present existing appears to be that of Dujardin (1845), but he gives no figures. Schneider ((1866), pl. I, fig. 3) gives an accurate figure of the dorsal lip, seen from the inner surface, but we are unable to find a figure of the tail of the male. The characters of this, and of the dorsal lip as seen from the outer surface being of considerable importance, we have prepared figures to illustrate these points, and we propose to amplify the description somewhat.

The size attained sometimes exceeds the measurements given by Dujardin. We have examined one female specimen (not in the present collection), from the brown bear, which measured as much as 240 mm. in length and about 4.5 mm. in thickness. This, however, appears to be exceptional. The anterior end of the worm (in spirit) is usually, though not invariably, curved towards the dorsal side. The lips are roughly semicircular in outline, and each carries two papillae, those of the dorsal lip (fig. 4) being equal and symmetrically arranged, while those of each ventro-lateral lip are rather unequal and asymmetrical, the papilla towards the ventral side being large, the more lateral papilla smaller and situated slightly further forward. The pulp of each lip sends out five processes, two in a transverse direction, near the ends of which are the papillae, and three anteriorly. Of the anterior processes two form large paired lobes which expand slightly and have a shallow longitudinal groove on their inner surfaces at their distal ends (*cf.* Schneider's figure). The third is the

¹ The last record may perhaps be due to a clerical error in the collector's label, *Vulpes* having been written by a *lapsus* for *Felis*.

median unpaired lobe, which is a supporting structure for the cuticle of the inner surface of the lip, and appears to end in short rays which spread out beneath the cuticle. The paired anterior lobes originate from the inner side of the main pulp of the lip somewhat behind its anterior limit, so that a kind of transverse groove, as described by Railliet and Henry for the type-species, is formed between the main mass and the anterior lobes. Marginal dentigerous ridges, composed of relatively very large and rather irregular teeth, are present.

The cervical alae are well-developed. The oesophagus is simple (without ventriculus) and club-shaped, very stout posteriorly (up to 0.95 mm.), and measures 4-5 mm. in length. There are no oesophageal or intestinal diverticula.

The caudal end of the male (fig. 5) is curved ventrally, but the extremity is usually recurved towards the dorsal side. The tail itself measures 0.45-0.5 mm. in length, is bluntly conical, and ends in a short spike which has a small terminal button, and thus resembles a terminal papilla. The postanal papillae correspond in number, though not exactly in position, with those of *T. leonina*, the genotype. There are (1) a group of four pairs near the tip of the tail, consisting of two very small ventral and two larger, more lateral pairs. Of the latter the more posterior is the most laterally situated, and the more anterior is the largest, of the group; (2) an isolated, quite lateral pair; (3) a large pair with double terminations, situated at the posterior limit of a kind of raised wall of cuticle which runs forward and round the cloaca, bounding a horseshoe-shaped depression. The edges of this "wall" are usually curved inwards, so that the terminations of the papillae face towards the mid-ventral line; (4) the first of a series of upwards of thirty pairs of papillae which extend for a considerable distance in front of the cloaca. These papillae are at first close together, and each row tends to resolve itself into two alternating rows, but further forward the row becomes simple and the papillae wider apart. The spicules are very short (about 0.65 mm.) and stout, and are tubular structures without alae, and covered with small granulations.

The tail of the female is short and bluntly conical, almost rounded posteriorly, but with a small papilla-like termination, as in the male. The vulva is situated at about the anterior third of the total length in young females, but in large examples the post-vulvar portion of the body appears to have grown more rapidly than the anterior part, so that the vulva divides the body in the proportion, roughly, of 2:5. The

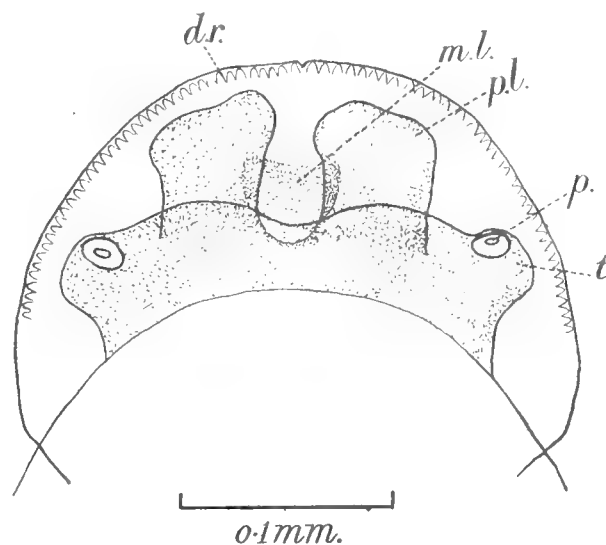


FIG. 4.—*Toxascaris transfuga*. Dorsal lip, viewed from exterior.

d.r., dentigerous ridge; m.l., median lobe of pulp; p.l., paired anterior lobe; p., papilla; t., transverse process of pulp.

narrow, convoluted vagina opens into a short (not exceeding 5 mm.) unpaired uterine chamber, as described by Dujardin, from which the two branches of the uterus run

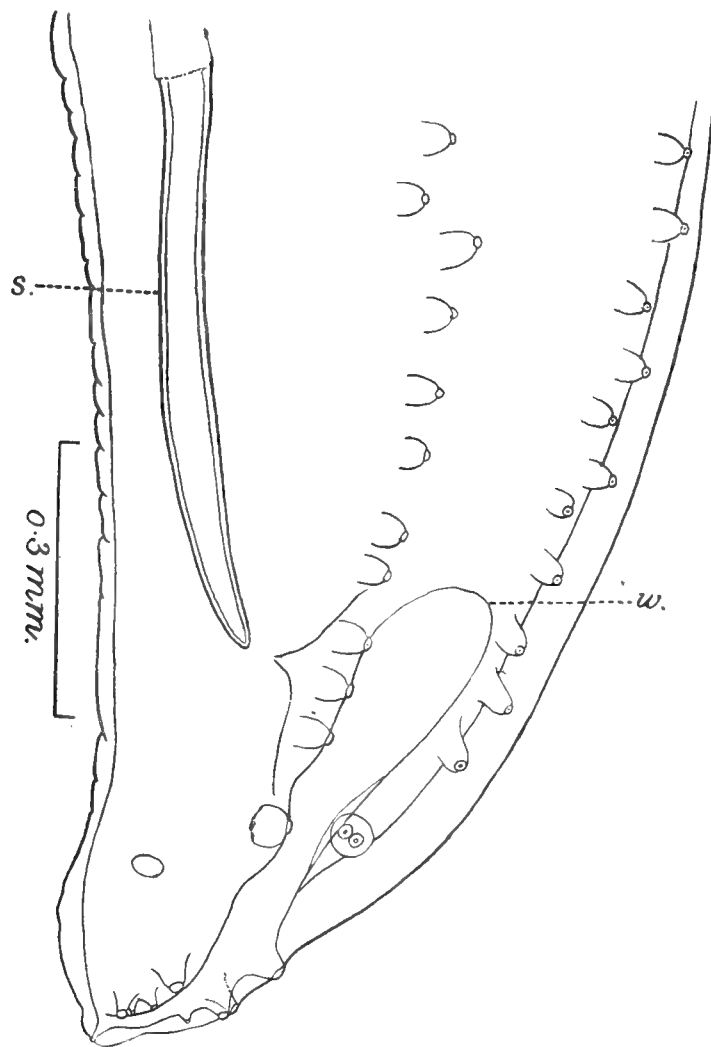


FIG. 5.—*Toxascaris transfuga*. Tail of male; latero-ventral view.

s., right spicule; w., wall of depression surrounding cloaca.

back parallel to each other, and nearly straight in large specimens. The coils of the [ovarian tubes, after running nearly to the posterior end of the body, return anteriorly as far as the level of the vulva. The eggs are oval (not globular), and have a thick, smooth shell measuring $0.0775-0.09 \times 0.06-0.075$ mm. When ready for laying, this shell appears to become covered, as in *Ascaris lumbricoides*, with an irregular external coat of a yellowish albuminoid substance, which perhaps gave Dujardin the impression of a "punctulated" shell. The content of the egg is unsegmented at the time of laying.

Genus *Ophidascaris*, Baylis, 1921.

Ophidascaris filaria (Duj., 1845).

This species occurred in abundance in the alimentary canal of *Python molurus* on nineteen occasions. We have also to record the presence of immature forms of various ages in the lung of *Python molurus* and *P. reticulatus*. In two cases the same animal

harboured adults in the intestine and larvae in the lung at the same time. The immature worms in the lung measured from about 9 to 60 mm. in length, but in the largest of them the lips had not yet acquired their definitive structure (except in one case where the label stated that the material came from the lung, but the accuracy of this statement may be doubted, as the uteri of the females already contained ova).

From the occurrence of the young forms in the lung of the python, it appears probable that the larvae have a course of migration within the body of the host, like that of the larvae of *Ascaris lumbricoides*, before finally establishing themselves in the alimentary canal.¹

¹ It has recently been shown by Ortlepp (*Jl. of Trop. Med. and Hyg.*, XXV, p. 97) that the embryos of *Polydelphis attenuata* are capable of partial development in the mouse, and that they migrate through the lungs as in the case of *Ascaris lumbricoides*. Our note was written before the appearance of Ortlepp's paper.

Ophidascaris naiae (Gedoelst, 1916).

We refer tentatively to this species forms found in the intestine of a cobra (*Naja tripudians*) and in the stomach and intestine of two kraits (*Bungarus fasciatus*). Their determination is open to question, all being young and not yet full-sized, although two of the females contain ova. Apart from measurements, they seem to agree fairly well with Gedoelst's (1916) rather brief description.

Genus **Polydelphis**, Duj., 1845.

Polydelphis sewelli, sp. nov.

(Figs. 6, 7.)

Host: Montpellier snake (*Coelopeltis monspessulana**). Locality: Khan-Yunis, Palestine, May, 1917.

Some Ascarids collected from the "abdomen and lung" of the above-named snake by Major R. B. S. Sewell prove to belong to the genus *Polydelphis*, and to the section of that genus in which the uterus has six branches.¹ The worms are relatively slender and of almost uniform thickness throughout. The male measures about 66 mm. in length and 1.2 mm. in thickness, the female 73 mm. and 1.4 mm. respectively. The cuticular striations are exceedingly fine. The diameter of the head is 0.3–0.34 mm. The lips (fig. 6) are somewhat hexagonal in outline, and slightly broader than long. Their anterior and lateral borders are somewhat emarginate. Marginal dentigerous ridges are present, and the pulp of the lip has two well-developed antler-like anterior lobes, each having two main divisions. The dorsal lip carries two simple lateral papillae, each ventro-lateral lip one large ventral and one very small lateral papilla. The oesophagus is simple, somewhat enlarged posteriorly, and measures about 5 mm. in length. There is, at least in some individuals, an intestinal caecum, which may reach a length of about 0.6 mm., or may be quite rudimentary and not more than 0.125 mm. long. A pair of very small cervical papillae is present at about 1.4 mm. from the anterior end. The nerve-ring is situated at 0.7–0.85 mm. from the same point.

The tail, in both sexes, is very short and rounded, and terminates in a small spike about 0.05 mm. long.

In the male, the tail (fig. 7) measures 0.25 mm. in length. The spicules are short, subequal and broadly alate. The right spicule measures 1.35 mm., the left 1.4 mm., and the dorso-ventral diameter of each is about 0.06 mm. The preanal

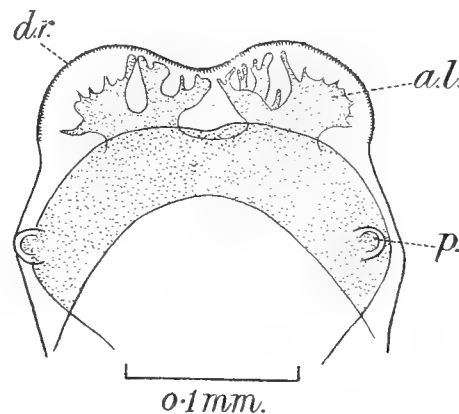


FIG. 6.—*Polydelphis sewelli*. Dorsal lip of female, viewed from exterior.

a.l., anterior lobe of pulp; d.r., dentigerous ridge; p., papilla.

¹ See Baylis (1921).

papillae are arranged in a single fairly regular and close series of about 43 on either side. There is also one papilla, more laterally situated, at about the same level as the fourth of the series, on each side. There are six pairs of postanal papillae, of which the first, or most posterior, papilla on each side is relatively large and dorsally placed; the second is very small and lateral; the third, fourth and fifth form a triangle, two of them being ventral and one more lateral; and the sixth is a large, double papilla near the cloaca and separated by a considerable space from the rest.

The tail of the female is 0.3 mm. long. The vulva is situated at about 34 mm. from the posterior end, dividing the body in the proportion of about 19 : 17. The

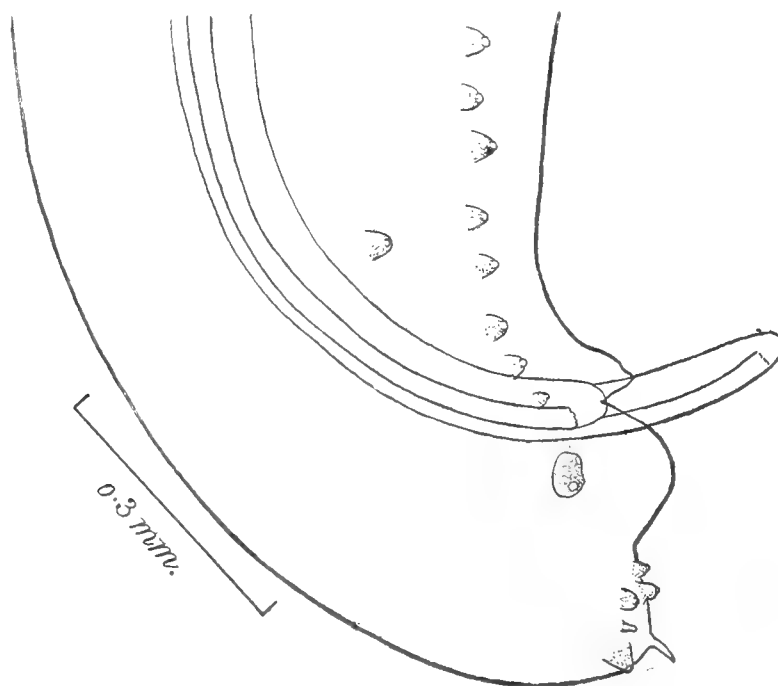


FIG. 7.—*Polydelphis sewelli*. Tail of male; lateral view.

narrow, irregularly coiled, muscular vagina leads into a common uterine chamber about 1.6 mm. long, which gives off the six parallel uterine branches posteriorly. These run back to a point about 15 mm. from the posterior end, where they pass into the ovarian tubes. The coils of the latter extend back to 10 mm. from the posterior end, and then run forward to the level of the vulva. The ova are roundish-oval or nearly spherical, and have a thick, finely granulated shell, measuring 0.09–0.1 × 0.075–0.087 mm.

***Polydelphis oculata* (v. Linst., 1899) (?).**

Two females from the stomach of a python from Assam (? *Python molurus* or *P. reticulatus*) may belong to this species, but are in too poor a condition to be determined with certainty.

***Polydelphis*, sp.**

[near to *P. hexametra* (Gedoelst, 1916).]

Two female specimens, one in very poor condition, were taken on separate occasions from examples of the common chameleon of India (*Chamaeleon calcaratus*). They belong to the section of the genus in which the number of uterine branches is

six, but it is impossible to determine whether the species is identical with the *Ascaris hexametra* of Gedoelst (1916), from an African chameleon.

Subfamily *ANISAKINÆ*, Railliet and Henry, 1912, *emend.* Baylis, 1920.

Genus *Porrocaecum*, Railliet and Henry, 1912.

Porrocaecum crassum (Deslongchamps, 1824).

One female specimen of this species was collected from a duck, at Bombay.

Porrocaecum depressum (Zeder, 1800).

(Fig. 8.)

Examples of this species occurred in the intestine of the cinereous vulture (*Vultur monachus*). The characters of the dorsal lip and of the male tail have been figured by Schneider (1866). We append a new figure of the dorsal lip for purposes of comparison with the next species, *P. angusticolle*, since the differences between these two species are so slight as to require emphasis.

Porrocaecum angusticolle (Molin, 1860).

(Figs. 9, 10.)

The material consists of a few complete specimens and some fragments from a kite (*Milvus govinda*).

This species is nearly related to the foregoing. The female was well described by von Drasche (1883), who figured the dorsal lip. The male has, up to the present, not been described. The principal character

which serves to distinguish the species from *P. depressum* is the shape of the pulp of the dorsal lip. In *P. angusticolle* the dorsal lip is almost hexagonal in outline. The main mass of the pulp resolves itself into two principal lobes, rounded anteriorly and joined by a saddle. Springing from the inner surfaces of these lobes are two processes which become visible anteriorly as two projecting plates, flattened and expanded distally. Towards the base of the lip there is on either side a cuticular band (fig. 9, *c.*) which stands out somewhat prominently. There is the usual pair of papillae on the dorsal lip, while a dentigerous ridge may be traced round the greater portion of the lip near its edge. Small triangular interlabia are present. Figs. 8 and 9 show the difference between this arrangement and that of *P. depressum*. In the case of the latter each of the main lobes divides anteriorly into two more or less finger-like processes, as described by Schneider, while internally there is a large, median lobe, rounded anteriorly, which is distinctly visible where it projects beyond the saddle joining the two main lobes.

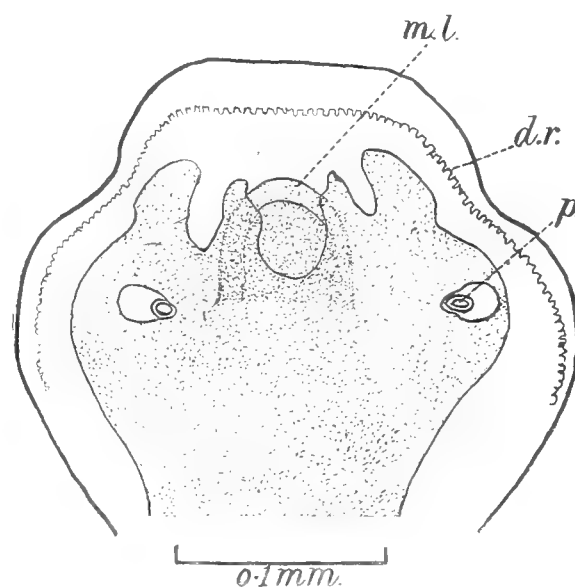


FIG. 8.—*Porrocaecum depressum*. Dorsal lip of female, viewed from exterior.

d.r., dentigerous ridge; *m.l.*, median lobe of pulp; *p.*, papilla.

The male measures up to 55 mm. in length and 1.1 mm. in thickness: the female 90 mm. and 1.5 mm. respectively. The cuticle has transverse striations about 17μ

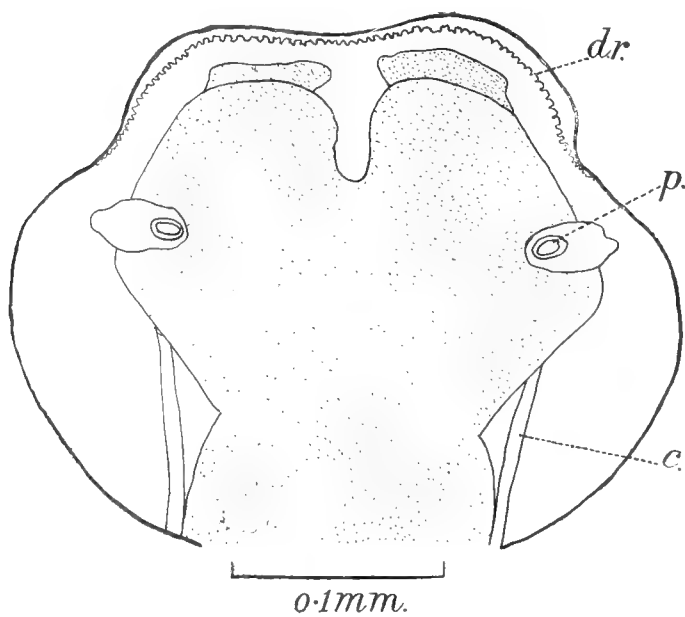


FIG. 9.—*Porrocaecum angusticolle*. Dorsal lip of female, viewed from exterior.

c., "cuticular band"; d.r., dentigerous ridge; p., papilla.

apart. Anteriorly the body is tapered for a considerable distance, forming a long, slender neck. The head is small, its diameter being 0.245 to 0.26 mm. There is a slight constriction at the junction of the head and neck. The oesophagus is 4.8 mm. long, including the short, oblong ventriculus, which measures 0.6 mm. in length. The anterior caecal prolongation of the intestine measures from 2.7 to 3.0 mm. in length. The nerve-ring is situated at about 0.85 mm. from the anterior end. At about 1.7 mm. from the head there is a pair of large, sessile cervical papillae. The excretory pore opens, as usual, just behind the base of the lips in the median ventral line.

The tail of the male (fig. 10) is conical and measures 0.39 mm. in length. About half-way between the cloaca and the tip of the tail there is a distinct constriction. There are no caudal alae. The postanal papillae are all sessile. There are about

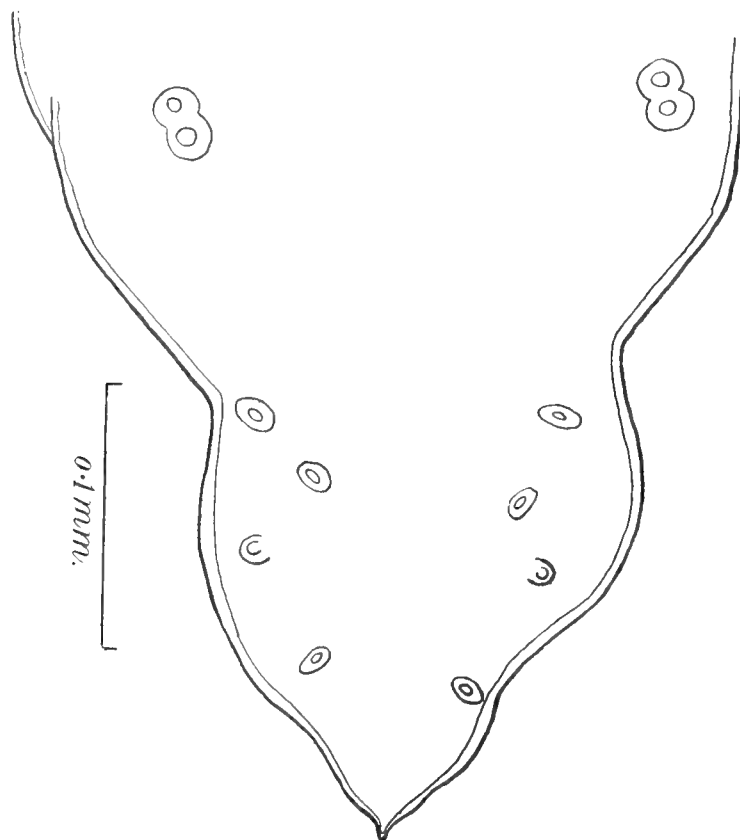


FIG. 10.—*Porrocaecum angusticolle*. Tail of male; ventral view.

twenty pairs of preanal papillae, the most posterior of which is situated just anteriorly to the corners of the cloacal opening. The postanal papillae consist of five pairs; a large, ventral pair of double papillae just behind the cloaca, and the remaining four pairs on the posterior half of the tail, *i.e.*, behind the constriction mentioned above. Two of these latter pairs are distinctly ventral and two ventro-lateral. The spicules are equal and simple (not alate). They measure 0.95 mm. in length.

The tail of the female is blunter than that of the male, and measures 0.7 mm. in length. The caudal papillae are situated at 0.2 mm. from the tip. The vulva is situated in the anterior half of the body, dividing the latter in the proportion of 3 : 5. The eggs measure 0.085–0.093 mm. \times 0.058–0.074 mm.

In addition to the difference in the pulp of the dorsal lip, there are certain other points in which this species diverges from *P. depressum*. The mature female of *P. depressum* is much shorter in proportion to its thickness than the female of *P. angusticollis*, and the vulva in *P. depressum* is situated further back, towards the middle of the body, the proportion in which it divides the body being about 5 : 6.

***Porrocaecum serpentulus* (Rud., 1809).**

(Fig. 11.)

Examples of this species occurred in the common crane (*Grus communis*) and in the demoiselle crane (*Anthropoides virgo*). The characters of the head, and more especially of the dorsal lip, have been described and figured by von Linstow ((1899),

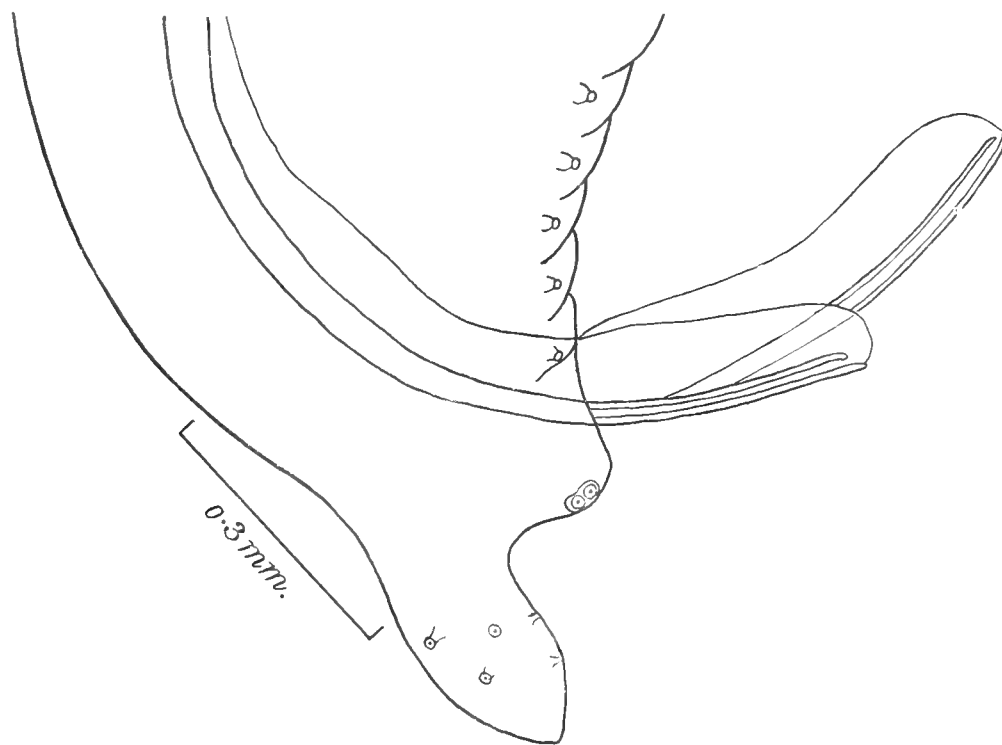


FIG. 11.—*Porrocaecum serpentulus*. Tail of male; lateral view.

p. 7; pl. 1, fig. 9). The bifurcation of the anterior lobes of the pulp of the lip appears to be less pronounced than is indicated in his figure. Dentigerous ridges are not, as he states, absent. In describing the tail of the male the same author

mentions four pairs of papillae on the finger-shaped terminal appendage, two ventral and two "dorsal." We find, in addition to two ventral and two subdorsal pairs, a fifth pair, lateral in position (fig. 11).¹ The one other postanal papilla on either side, mentioned by von Linstow, is on the thicker portion of the body, and is a double papilla, facing posteriorly. There is a regular series of about 15 preanal papillae on either side, as stated by von Linstow. The spicules are equal in length (1.25 mm. in a moderately large specimen). Each is composed of a tubular shaft having a transversely striated appearance and gradually increasing in diameter towards its base, and two very broad membranous alae.

This species, when taken from cranes, has a relatively short and stout build, some females attaining a diameter of about 4 mm. Some specimens from *Ardea cinerea* in the British Museum are so slender in proportion to their length, as compared with those from cranes, that it seemed probable that they belonged to a different species. We have found no important difference, however, in the structure of the head or of the male tail, and therefore conclude that the forms in cranes and in herons are all *P. serpentulus*.

***Porrocaecum reticulatum* (v. Linst., 1899).**

(Fig. 12).

Syn. *Ascaris reticulata*, v. Linstow (1899), p. 7; pl. I, fig. 11.

Ascaris ardeae, Smith, Fox and White (1908), p. 287; pl. VI, figs. 1-7.

(nec *Ascaris ardeae*, Frölich, 1802; *A. ardeae*, Diesing, 1851; *A. ardearum*, Rud., 1819.)

Material from the intestines of the Eastern purple heron (*Ardea manillensis*), the night heron (*Nycticorax griseus*) and an egret (species not mentioned), all from the Calcutta Zoological Garden, appears to us to be referable to *Ascaris reticulata*. All our specimens, however, are rather small compared with the measurements given by the authors cited, and although the sexual characters are developed and the females already contain ova, it is probable that they had not yet attained their full size. On comparison of the descriptions and figures given by von Linstow and by the American authors, we feel no doubt as to the identity of *A. reticulata* and *A. ardeae*, Smith, Fox and White. In both cases, however, important points appear to have been overlooked by the observers, as our own material shows. Von Linstow states that interlabia and dentigerous ridges are absent, while omitting any description of the structure of the oesophagus and the anterior part of the intestine. The American authors, on the other hand, observed the well-developed interlabia and the presence of dentigerous ridges, but state that the oesophagus has no "bulb", and make no mention of an intestinal caecum. From our own observations it is clear that the characters of the head have been accurately described by Smith, Fox and White. It is just possible to understand how the interlabia were overlooked by von Linstow, since in a cleared specimen in certain positions they are almost entirely hidden by the lips, and their delicate outlines become very elusive. It is less easy to explain how the American authors failed to see the extremely well-developed intestinal caecum, which runs forward beside the oesophagus for a considerable

¹ Our figure is taken from a specimen from *Grus australasiana*, in the British Museum, and not from Indian Museum material.

portion of its length, and is quite a conspicuous organ. The rather short, oblong ventriculus is less conspicuous, but is not difficult to observe in a well-cleared specimen. All these characters, taken together, leave no doubt as to the generic position of the species.

The characters of the caudal end of the male appear to have been adequately described and figured by Smith, Fox and White, (von Linstow's material consisted of females only)—with the remarkable omission of any mention of an accessory piece, in

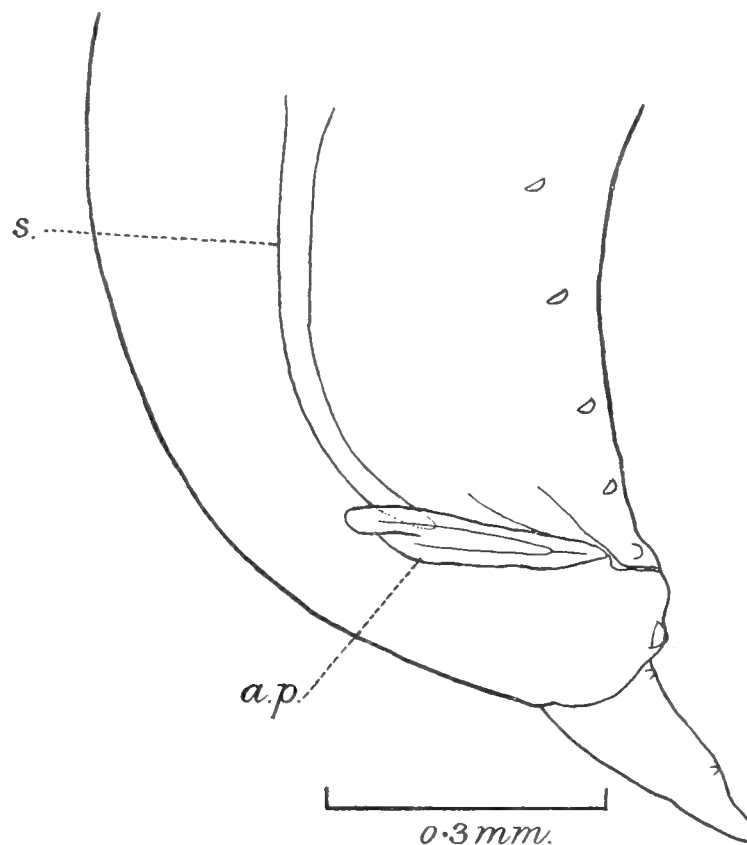


FIG. 12.—*Porrocaecum reticulatum*. Tail of male; lateral view.
a.p., accessory piece; s., right spicule.

addition to the two spicules. The presence of such a structure in an Ascarid is highly remarkable, yet in the material at our disposal every male possesses a conspicuous accessory piece (fig. 12, a.p.) composed of clear, yellowish-brown chitin. This organ appears smooth, whereas the spicules (which are of a darker colour and are simple, tubular structures, without alae), have a rough, granular appearance. As regards the caudal papillæ of the male, we are in agreement with the description given by the American authors. There are two very small pairs on the finger-like caudal appendage; one large postanal pair just before the constriction of the tail; and an anterior row in which we have counted five on either side, commencing with a pair at the level of the cloaca.

The almost spherical eggs, in our specimens, are slightly smaller than the measurements given by the former describers, but this is possibly due to the immaturity of the females. The egg-shell is pitted externally, as described by the Ameri-

can writers, the walls between the pits doubtless forming the "network of ridges" referred to by von Linstow.

This species is readily distinguished from *P. serpentulus* by the absence of cephalic alae, and by the simple character of the spicules and the presence of an accessory piece in the male.

Porrocaecum pristis, sp. nov.

(Figs. 13-15.)

Host: Saw-fish (*Pristis perotteti*). Position: intestine. Locality: Ulubaria, R. Hughli.

The male measures up to 26.6 mm. in length and 0.74 mm. in thickness; the female 34.2 mm. and 1.06 mm. respectively. The diameter of the head is 0.16-0.18 mm. The cuticle has transverse striations 8.7-10 μ apart. The lips (fig. 13) are small, and pass into the neck without any constriction at their bases. Each has a

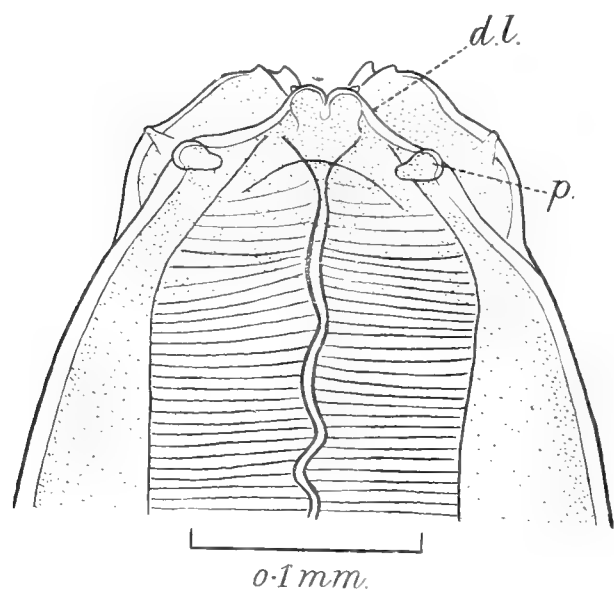


FIG. 13.—*Porrocaecum pristis*. Head of female; dorsal view.

d.l., dorsal lip; p., right papilla of same.

narrow, bilobed, anterior process, carrying two small cuticular projections on its inner surface. The dorsal lip is shorter than the ventro-lateral lips, and has two large papillae. Each ventro-lateral lip has one large, lozenge-shaped ventral papilla and a much smaller lateral papilla, situated a little more anteriorly. Dentigerous ridges are present, at least on the anterior processes of the lips. The teeth are very small. Interlabia are absent. The oesophagus has a straight posterior glandular portion, or ventriculus, of oblong shape. The distance from the head end to the posterior end of the ventriculus is 2.3-2.7 mm. The ventriculus is 0.6 mm. long in the male,

0.75-0.78 mm. in the female. The anterior caecal prolongation of the intestine measures 0.95-1.3 mm. in length. There is a pair of prominent, rounded, cervical papillae at 0.65-0.67 mm. from the anterior end. The nerve-ring is situated at 0.46-0.53 mm. from the same point. The excretory system terminates, as usual in the genus, in a long unicellular gland with a very narrow duct leading to the excretory pore, which is situated just between and behind the ventro-lateral lips.

The tail of the male (figs. 14, 15) is conical, slightly curved ventrally, and measures 0.38 mm. in length. There are slight caudal alae, and most of the papillae have rather long, rib-like pulps. There are about 40 pairs of preanal papillae, and in addition to these there is one median sessile papilla on the anterior lip of the cloaca. One pair of papillae, apparently belonging to the preanal series, is situated just at the corners of the cloacal opening. There are seven pairs of postanal papil-

lae, of which the second and third from the tip of the tail are laterally, the rest ventrally situated. The fifth papilla on either side is larger than the rest, and has double terminations. The spicules are equal, simple and without alae. They measure only 0.9 mm. in length.

The tail of the female is bluntly conical and measures 0.44 mm. in length. The caudal papillae are situated at 0.162 mm. from the tip. The vulva is somewhat be-

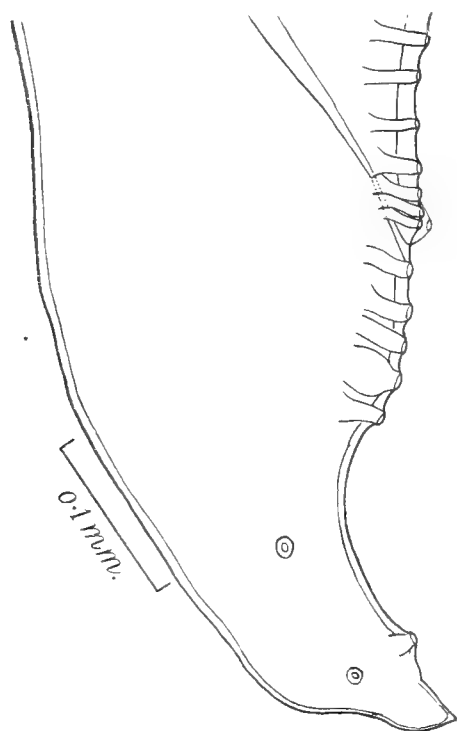


FIG. 14.—*Porrocaecum pristis*. Tail of male; lateral view.

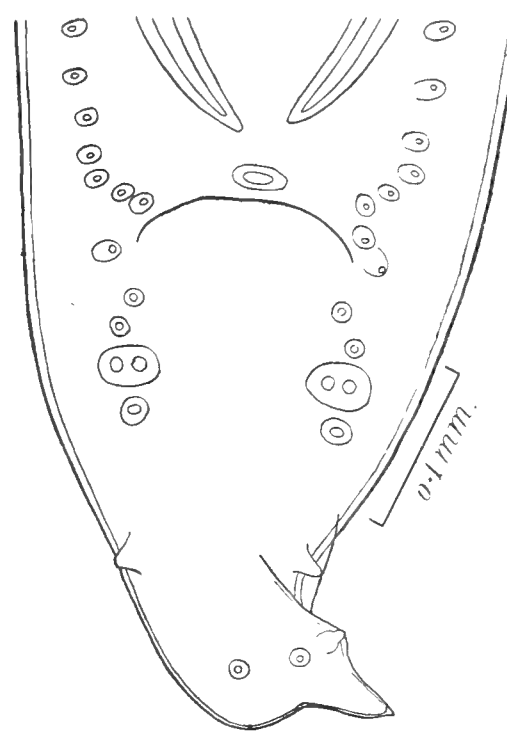


FIG. 15.—*Porrocaecum pristis*. Tail of male; ventral view.

hind the anterior third of the body—at 12.3 mm. from the anterior end in a specimen 34.2 mm. long. The muscular vagina, which runs posteriorly, is very short (about 0.7 mm.), expanding in its posterior half to a diameter of 0.19 mm. This swollen portion is packed with ova. Then follows a wide uterine reservoir, about 2 mm. long, which gives off posteriorly the two uterine branches. These run almost straight towards the posterior end. The posterior limit of the coils of the ovarian tubes is about 1.5 mm. from the posterior end. The ova are spherical, with a thin shell, measuring 0.0475 mm. in diameter. The content of the egg is unsegmented when ready for laying.

Ascaris circularis v. Linst. is recorded as a parasite of *Pristis antiquorum* in the Cameroon. Von Linstow (1907), in his description of it, mentions the presence of an intestinal caecum, and it is not improbable that the species also belongs to the genus *Porrocaecum*. But the figure of the dorsal lip (*l. c.*, pl. 6, fig. 1) is sufficient to differentiate it from *P. pristis*.

Genus **Contracaecum**, Railliet and Henry, 1912.

Contracaecum spiculigerum (Rud., 1809).

Hosts:

Little cormorant (*Phalacrocorax javanicus*).

Indian shag (*Phalacrocorax fuscicollis*).

Contracaecum rosarium (Connal, 1912).

(Fig. 16.)

The collection contains worms taken on two occasions from the night-heron (*Nycticorax griseus*). The material consists in one case of two immature males, the tails of which are eroded and useless for purposes of identification, and in the other case of three immature females and one rather damaged, immature male. We have

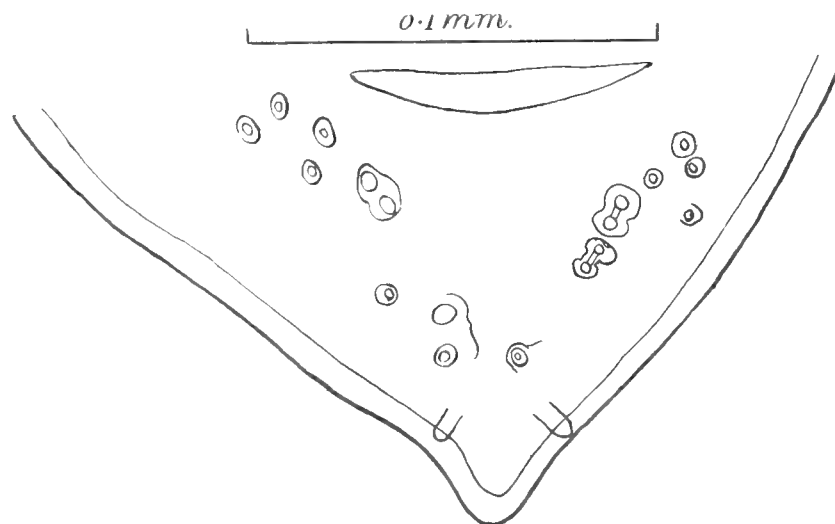


FIG. 16.—*Contracaecum rosarium*. Tail of male; ventral view.

assigned these to *Contracaecum rosarium*. There is nothing in Connal's (1912) description to indicate a difference between his species and *C. microcephalum* (Rud.), except that there are three pairs of postanal papillae in the male. With the material at our disposal it is not possible to redescribe the species. The head generally and the dorsal lip in particular are indistinguishable from those of *C. microcephalum*. However, the tail of the male in the second set shows quite clearly that there are more than three pairs of postanal papillae, and that the number and arrangement of these papillae (which, in the only specimen available, are unfortunately somewhat asymmetrical), will serve to differentiate this species from *C. microcephalum*. There are nine pairs of postanal papillae. Those of the pair at the tip are stalked and nipple-like, while the remainder are flattened. The fifth pair have double terminations.

Our best thanks are due to Dr. L. Gedoelst, of Brussels, for kindly obtaining for us the loan of the type-material of *Kathleena arcuata*, Gedoelst, 1916, the property of the Congo Museum at Tervueren. One of us (Baylis, 1920 a) had already suggested that this form was probably identical with *Contracaecum microcephalum* (Rud.), and our examination of the material confirms this view.

Contracaecum incurvum (Rud., 1819) (?).Syn. *Ascaris incurva*, Rud.

(Figs. 17, 18.)

Two male individuals of an Ascarid from the stomach of the peacock fish (*Histiophorus gladius*) are probably referable to this species, though they are small and perhaps not fully mature. The characters of the oesophagus and of the head

show them to belong to the genus *Contracaecum*. The head corresponds fairly well with the figures given by Schneider ((1866), pl. II, figs. 11 *a* and *b*) and by Linton ((1901), pl. IV, figs. 29, 30), while the presence of a long intestinal caecum has been noted by Dujardin (1845) and by Linton (*l. c.*), although the oesophageal appendix was not observed, and Dujardin placed the species among the forms now considered to belong to the genus *Porrocaecum*.

The characters of the caudal end in the male do not appear to have been accurately described. Stossich ((1902), pl. III, fig. 1) shows only two pairs of postanal papillae, and a peculiarly shaped tail. Linton's figure ((1901), pl. IV, fig. 32) is scarcely adequate for determination. For these reasons it may be

worth while to give some details and figures of the anatomy of the present specimens.

The larger of the two specimens measures 34.3 mm. in length and 0.55 mm. in thickness. The diameter of the head is about 0.19 mm. The distance from the head end to the posterior end of the oesophagus (including the small spherical ventriculus) is about 3 mm. The ventriculus is 0.16 mm. in diameter. The oesophageal appendix is relatively very long (3 mm.), and the intestinal caecum runs forward to a point 1.05 mm. from the head end. The cervical alae originate just dorsally to the lateral interlabia, and extend back to a point about 2 mm. from the anterior end. They are about 0.05 mm. wide at the widest part. The body is relatively slender and of almost uniform thickness throughout. The cuticular striations are coarse (up to 0.0125 mm. apart), and form small saw-teeth in optical section. The lips have sinuous margins anteriorly and laterally, and are produced into broad cuticular flanges at the posterior corners. There are deep grooves running round the bases of the lips from the interlabia, similar to those characteristic of the genus *Ophidascaris*. The interlabia are rather short and compressed between the lips. The ventro-lateral lips are somewhat asymmetrical in shape, though hardly so much so as is indicated by Schneider's figure ((1866), pl. II, fig. 11 *b*), the ventral angles being considerably produced. The dorsal lip bears a pair of rather small, rounded papillae; the ventro-lateral lips one each, towards the ventral side. There is a pair of conspicuous, but sessile, cervical papillae situated dorsally to the cervical alae and at 0.65 mm. from the anterior end. The nerve-ring is at 0.55 mm., and the excretory pore at 0.68 mm., from the anterior end.

The tail of the male (fig. 18) is 0.2 mm. long, sharply tapering, curved ventrally and drawn out at the tip into a slender spike. There are no caudal alae. The ventral surface of the caudal region, from about 0.7 mm. in front of the cloaca forward

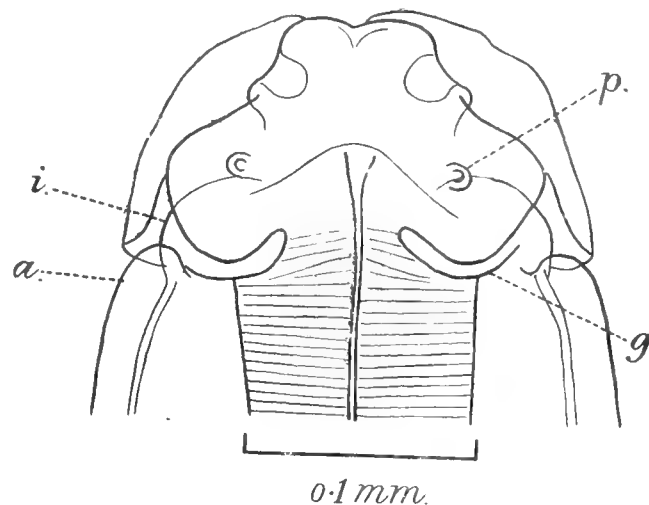


FIG. 17.—*Contracaecum incurvum*. Head of male; dorsal view.

a., cervical ala; *g.*, groove in cuticle; *i.*, interlabium; *p.*, papilla.

for about 2 mm., has the cuticle raised into pronounced longitudinal ridges, interrupted by transverse grooves at intervals of 0.03 mm. The spicules are equal in

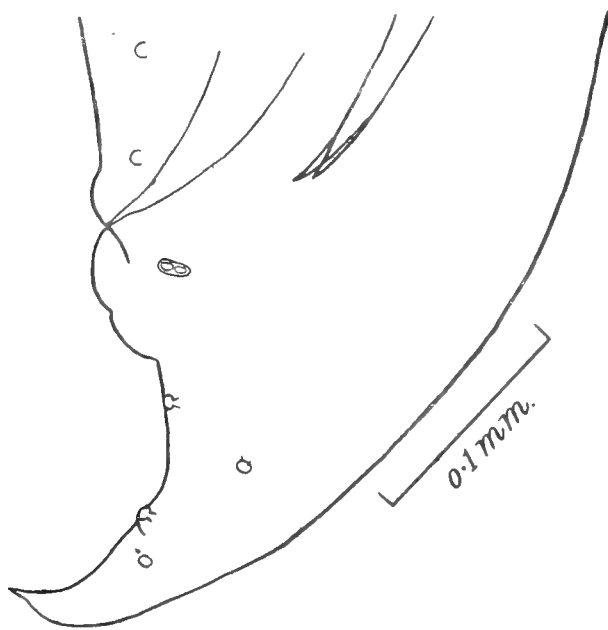


FIG. 18.—*Contracaecum incurvum*. Tail of male; lateral view.

length (4.1 mm.) and have broad alae, except for a short distance at the tip. The caudal papillae are all rather small and sessile. There are about 15 pairs of preanal papillae, those near the cloaca small and close together, the more anterior gradually becoming larger and wider apart. There is also a pair of double adanal papillae, and four postanal pairs, of which two are ventral and two lateral.

The host in which the adult form of this species has been commonly recorded is the sword-fish, *Xiphias gladius*,¹ and the worm appears to be very widely distributed and to attain a large size. Linton (1901) has also recorded immature stages, probably of this species, from several other fishes. In the pre-

sent collection there are included some encapsuled larvae from the mesentery of *Nandus marmoratus* and *Wallago attu*, and from the body-cavity and peritoneum of another (unnamed) fish, which show the same oesophageal structure as the specimens from *Histiophorus*, and are perhaps to be referred to the same species. The largest of these larvae is about 33 mm. long. The oesophagus does not yet exceed 3 mm. in length, and the oesophageal appendix 0.5 mm. The intestinal caecum is already of considerable length. The lips are not yet formed, so that it is impossible to confirm the determination by a study of their structure.

Contracaecum tricuspe (Gedoelst, 1916).

This species was described by Gedoelst from an African heron. We have to record its appearance at Calcutta in the Indian darter or snake-bird (*Plotus melanogaster*).

Contracaecum engonium, sp. nov.

(Figs. 19, 20.)

A single male specimen was collected from the black stork (*Ciconia nigra*). It measures 13 mm. in length and 0.57 mm. in maximum thickness. The head measures 0.19 mm. in diameter, and is constricted off from the body. The interlabia are simple and undivided at the tip. The dorsal lip (fig. 19) is rounded anteriorly and carries a pair of double papillae. The pulp roughly follows the shape of the lip, but is indented on its anterior edge. Each lip is provided with a pair of flattened processes springing from the internal surface and projecting anteriorly like two small horns at the shoulders of the lip. The muscular portion of the oesophagus measures

¹ *Histiophorus gladius*, though probably related, not distantly, to *Xiphias*, is not the same fish, and appears to be a new host.

2.75 mm. in length and 0.14 mm in thickness. The intestinal caecum is broad, and reaches to within 0.69 mm. of the head-end. There is a short ventriculus, measuring about 0.14 mm. in length and about as broad as long. From this is given off a posterior caecum which is 0.7 mm. in length and 0.15 mm. in thickness.

The spicules are equal, long and slender, measuring 1.8 mm. in length and 0.022 mm. in breadth. They consist of a cylindrical shaft with narrow lateral alae. The cloaca is situated at 0.125 mm. from the tip of the tail (fig. 20), which is abruptly attenuated to a conical point. There are ten pairs of post-anal papillae, of which the first, fourth, fifth and seventh are latero-ventral. The remaining six pairs are lateral and pedunculate, and fall into two groups: a group

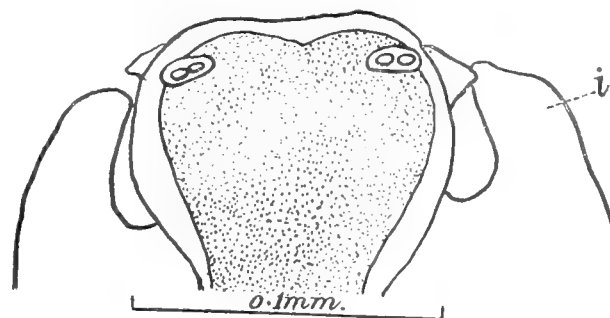


FIG. 19.—*Contracaecum engonium*. Head of male: dorsal view.

i., interlabium.

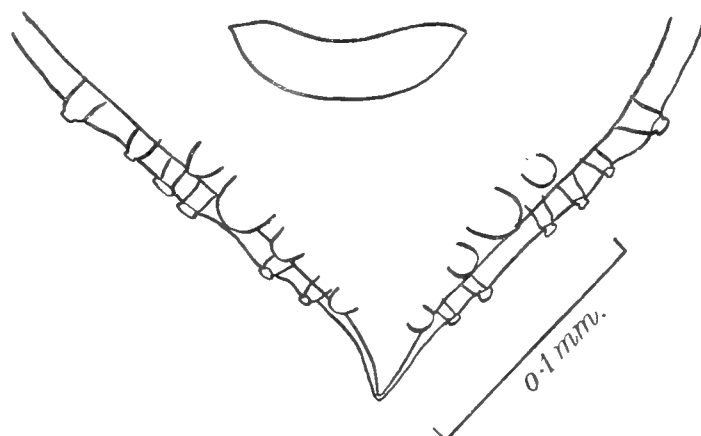


FIG. 20.—*Contracaecum engonium*. Tail of male: ventral view.

of two pairs (the second and third) close to the tip, and a group of four pairs extending from about the middle of the tail almost to the cloaca.

***Contracaecum schizothoracis*, sp. nov.**

(Figs. 21, 22.)

Host: *Schizothorax zarudnyi*.* Position: intestine. Locality: Hamun-i-Helmand, Seistan, Eastern Persia.

This is a relatively short and stout species, tapering to a considerable degree at each end. The male is 16.75 mm. long and 0.8 mm. thick; the female 20.2 mm. and 1.0 mm. respectively. The cuticular striations are 4–5 μ apart. The diameter of the head is 0.2–0.22 mm. The lips (fig. 21) are small, with a deep indentation in the middle of the anterior margin, cuticular flanges at the sides, and a projection on the inner surface at each anterior angle. The dorsal lip bears two large, lozenge-shaped papillae, the ventro-lateral lips one each towards the ventral side. The interlabia

(fig. 21, *i.*) are almost as long as the lips, and are bifurcate at the tip. There are no cervical alae. The distance from the head-end to the posterior end of the oesophagus (including the small, almost globular ventriculus) is 2.2–2.5 mm. The ventriculus measures 0.18 mm. in length and 0.24 mm. in width. The oesophageal appendix is

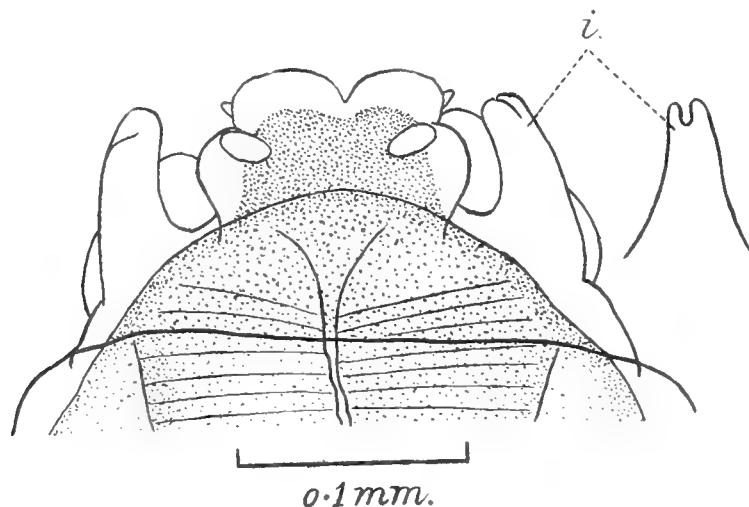


FIG. 21.—*Contracaecum schizothoracis*. Head of female; dorsal view.
i., interlabium.

about 0.6–0.7 mm. long, and the intestinal caecum runs forward to a point about 0.5 mm. from the head-end. The prominent cervical papillae and the nerve-ring are situated at 0.3–0.4 mm. from the anterior end. The position of the excretory pore was not made out.

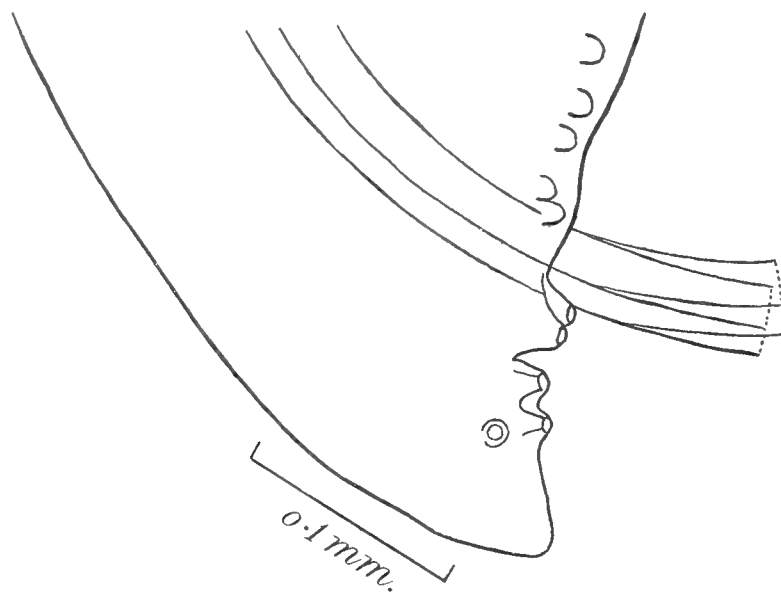


FIG. 22.—*Contracaecum schizothoracis*. Tail of male; lateral view.

The tail in both sexes is short and bluntly conical. In the male, it is 0.12 mm. long and has no alae. The spicules are very long (at least 5.5 mm.) and provided with broad alae. Their length could not be accurately measured owing to the whole of the extruded portion being thrown into spiral coils. Their dorso-ventral diameter is about 0.035 mm. There is a regular series of about 23 pairs of small preanal

papillæ. The postanal papillæ are arranged in five pairs, of which the most posterior is lateral, the rest ventral. The two anterior pairs are at almost the same transverse level, just opposite to the posterior lip of the cloaca.

The tail of the female is 0.23 mm. in length. No caudal papillæ were seen. The vulva is situated a little behind the anterior fifth of the body (at 4.3 mm. from the anterior end). The simple muscular vagina, after a preliminary coil anteriorly, pursues a very irregular course posteriorly to about 1.5 mm. from the vulva before the origin of the uterine branches. These are about 8 mm. in length, their posterior ends serving as receptacula seminis. The ovarian tubes appear to double upon themselves some distance in front of the anus, and return towards the anterior end. The ova are nearly spherical, with a thick shell measuring 0.0575–0.0725 mm. in diameter.

Genus *Amplicaecum*, Baylis, 1920.

Amplicaecum varani, sp. nov.

(Figs. 23, 24.)

A few specimens of an Ascarid which appears to belong to the genus *Amplicaecum* were collected on one occasion from the intestine of *Varanus salvator* in the Zoological Garden. The only Ascarid hitherto recorded in *Varanus*,¹ so far as we are able to discover, is *Ophidascaris filaria*, which is, however, usually found in pythons. This is a much larger species, and could not be confused with the present form.

There were several adult males, but unfortunately only one fully mature female. The measurements in the following description were taken from this female and the three largest males.

The male measures 22.2–24.9 mm. in length, the female 24.75 mm. The greatest thickness is 0.73 mm. in the male, 0.8 mm. in the female. The diameter of the head is 0.25–0.29 mm. The cuticular striations are fine (about 0.005 mm. apart).

The lips (fig. 23) are nearly square in shape, and have a deep indentation on the inner surface at the anterior margin. The interlabia are very small and almost hidden by the lips. From the interlabia well-marked semicircular grooves in the cuticle run round the bases of the lips, nearly meeting in the median line of each lip. These grooves have upstanding membranous cuticular borders posteriorly. The dorsal lip has two moderately large papillæ. Each ventro-lateral lip has one large, lozenge-shaped papilla towards the ventral side, and one very small papilla laterally. The dentiger-

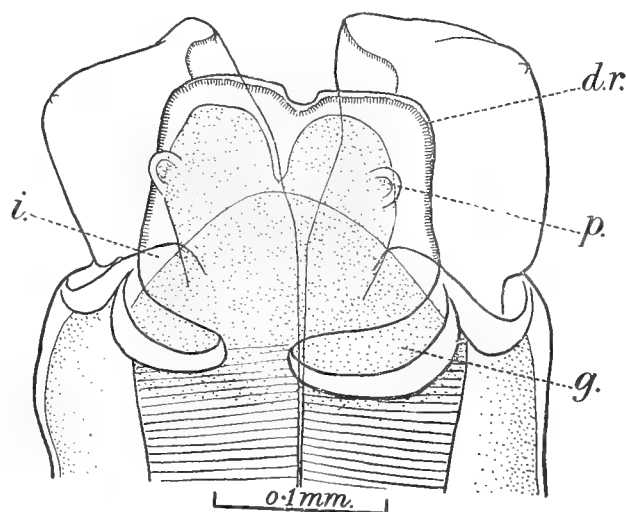


FIG. 23.—*Amplicaecum varani*. Head of female; dorsal view.

d.r., dentigerous ridge; g., groove in cuticle; i., interlabium; p., papilla.

¹ See Baylis (1921).

ous ridges are well-developed and marginal. The oesophagus is without bulb or ventriculus, and measures 3.5–4.7 mm. in length. A well-developed, but rather

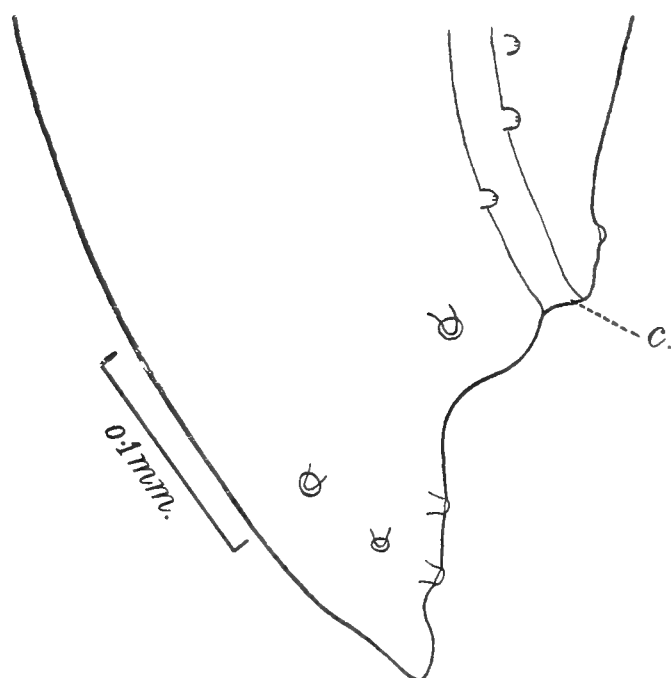


FIG. 24.—*Amplicaeum varani*. Tail of male; lateral view.

c., cloacal aperture.

narrow, intestinal caecum, 0.9–1.0 mm. long, is present, running forward beside the oesophagus. The very small cervical papillae are situated at about 0.9 mm. from the anterior end, the nerve-ring at 0.7–0.74 mm., and the excretory pore at 0.9 mm., from the same point.

In the male, the conical tail (fig. 24) is only 0.16 mm. long, and there are no caudal alae. The two equal spicules are remarkably short (0.5 mm.) and are simple, cylindrical, slightly tapering rods. There are some 32 pairs of preanal papillae, those nearest to the cloaca being very small, the more anterior much larger. In addition to these there is one small, sessile, median papilla on the anterior lip of the cloaca. The postanal papillae are arranged in five pairs, of which the first

and third from the tip of the tail are ventral, the rest lateral, in position.

In the female, the tail is conically pointed and 0.32 mm. long. There is a pair of caudal papillae at 0.065 mm. from the tip. The vulva is situated at 6.5 mm. from the anterior end of the body, i.e., a little behind the anterior quarter. There is a long muscular vagina, following a very irregular course in a generally posterior direction, but with occasional forward loops. The two uterine branches are wide and thin-walled, and run backward with a rather sinuous course. The coils of the ovaries occupy the posterior region of the body, as far back as about 1.5 mm. from the tip of the tail. The eggs are oval, with a rather thin shell, measuring 0.0675–0.075 × 0.05 mm.

Genus *Dujardinia*, Gedoelst, 1916.

Dujardinia helicina (Molin, 1860).¹

We refer to this species two immature females from the stomach of *Crocodilus porosus* from Port Canning, Gangetic Delta. The specific determination is possibly

¹ Gedoelst (1916) describes a form, from an African crocodile, which he identifies with *A. helicina*, Molin, erecting for it a new genus *Dujardinia*. Skrjabin (1916) also describes what he believes to be *A. helicina*, Molin, from an African crocodile, and proposes for it the new genus *Trispiculascaris*. Travassos (1920) considers both Gedoelst's and Skrjabin's species distinct from *A. helicina*, Molin, and renames Gedoelst's form *Dujardinia dujardini*, and that of Skrjabin *Trispiculascaris trispiculascaris*. As, however, this author gives no morphological reasons for his views, we are unable to discuss them. Examination of African material existing in the British Museum, and already regarded as *Dujardinia helicina* (Molin) of Gedoelst, shows that the oesophageal and intestinal structure described by Gedoelst is present. This is definitely stated by Skrjabin to be absent in his material. On the other hand, an accessory piece similar to that

open to doubt. *Ascaris helicina* was originally described from *Crocodilus acutus*¹ in America, but has also been recorded from Africa in *Crocodilus niloticus* more than once, though not hitherto from an Indian crocodile.

Larvae of Anisakinae.

Immature Ascarids of various sizes (the longest measuring about 18 mm.) occurred under the peritoneum of the fish *Pelamys chилиensis*. They have a long ventriculus, and may be the larvae either of an *Anisakis* or of a *Porrocaecum*. If the latter, the intestinal caecum has not yet been developed.

Family HETERAKIDAE, Railliet and Henry, 1914.

Subfamily HETERAKINAE, Railliet and Henry, 1912.

Genus *Heterakis*, Duj., 1845.

Heterakis papillosa (Bloch, 1782).

Syn. *H. vesicularis* (Frölich, 1791).

The collection contains examples of this species from the following hosts:

Ring-necked pheasant (*Phasianus torquatus**).

Common hill-partridge (*Arboricola torqueola*).

Heterakis isolonche, v. Linst., 1906.

Hosts:

Crimson horned pheasant (*Tragopan satyra*).

Monál (*Lophophorus impeyanus*).

Blood pheasant (*Ithagines cruentus*).

An accurate description of this species has been given by Lucet and Henry (1911). The remarkable cuticular "papillae" usually present in the neighbourhood of the vulva of the females are not constant in number or position, and some individuals have none. Moreover, they correspond very closely in diameter with the internal diameter of the preanal sucker of the male. We are therefore inclined to believe that they are actually caused by the action of the sucker of the male in attempting to copulate. It may be that the cuticle of this part of the ventral surface of the female is soft and readily drawn into the sucker. In any case, these raised "hold-

described by Skrjabin is also present. The spicules are of great relative length and very slender. Gedoelst gives the length of the spicules as 230μ , and does not mention an accessory piece. 280μ is slightly less than the length of the accessory piece in our material, and we suggest that this structure has been mistaken for the spicules. We are therefore inclined to believe that our material and Gedoelst's belong to the same species, but that the form described by Skrjabin is distinct, unless the important structure of the alimentary canal has been overlooked. The structure of the oesophagus and the presence or absence of diverticula of the alimentary canal are characters which we regard as of considerable systematic value among the Ascaridae; but, as has been shown above (see *Porrocaecum reticulatum*) an accessory piece may occur in an isolated species of a genus in which it is normally absent, and we do not feel that it is of equally great systematic importance.

We wish here to acknowledge our indebtedness to Prof. R. T. Leiper for kindly assisting us to consult Skrjabin's paper.

¹ More correctly, *C. americanus*.

fasts" would be very effective in assisting close union if, as we suggest, they are embraced by the sucker.

***Heterakis longecaudata*, v. Linst., 1879.**

This species, which is very closely related to the genotype, *H. papillosa*, appears to have been recorded up to the present only in its type-host, *Megacephalon maleo*, a bird of the Megapodiid family, found in Celebes. It is not improbable, however, that its exceedingly close resemblance to *H. papillosa* has led to its being often confused with that species when found in other hosts. In the Zoological Garden, Calcutta, it occurred in the following birds:—

Monál (*Lophophorus impeyanus*).

Crimson horned pheasant (*Tragopan satyra*).

Swamp-partridge (*Francolinus gularis*).

Red spur-fowl (*Galloperdix spadicea*).

In the two first-mentioned hosts it appears to occur not uncommonly, though in small numbers, if we may judge from the small amount of material available. In the horned pheasant it sometimes occurred together with *H. bosia* or *H. isolonche*, or both. In the monál both *longecaudata* and *isolonche* occur, but we have not found them together.

It may be useful to amplify somewhat the short original description given by von Linstow (1879). The measurements here given are based on examples from the monál.

The length of the male is from 7.9 to 9.1 mm., that of the female 7.9 to 9.6 mm. The maximum thickness, measured dorso-ventrally, is 0.3–0.4 mm. The cuticular striation is so fine as to be scarcely visible in some specimens. The anterior end of the worm is usually curved towards the dorsal side. The three lips are simple and very similar to those of *H. papillosa*. The diameter of the head at the base of the lips is 0.08 mm. There are well-developed lateral alae, commencing at a short distance from the head, and running throughout the greater part of the length of the body. At 0.55 mm. from the anterior end a pair of small cervical papillae project into the alae. The oesophagus, measured from the anterior end of the worm to the back of the bulb, is 1.0–1.1 mm. long. It commences with a small anterior section, or "pharynx," narrower than the oesophagus proper and 0.08–0.09 mm. long. Posteriorly the oesophagus passes gradually into a large, pear-shaped bulb, 0.18–0.22 mm. in diameter, and containing a well-developed valvular apparatus. The nerve-ring is situated at 0.3 mm., and the excretory pore at 0.45–0.5 mm., from the anterior end.

In the male, the caudal end is provided with very broad alae. The tail proper (*i.e.*, the postanal portion) measures 0.45–0.5 mm. in length, and tapers beyond the alae to a fine filament. The preanal sucker measures 0.08–0.09 mm. in diameter, and is situated at 0.1–0.15 mm. from the cloaca. Both spicules are alate, the alae of the short left spicule being very broad, those of the long right spicule much narrower. The shorter spicule has a double bend near the tip, like that of *H. papillosa*, while the

tip of the longer spicule is simple and straight. The lengths of the spicules are 2.38 mm. and 0.75 mm. respectively in a large specimen. The twelve pairs of caudal papillae are arranged in the manner indicated by von Linstow, with the exception that of the two pairs nearest to the posterior end one is situated laterally, the other (slightly larger) ventrally, and both are at an equal distance from the tip of the tail. In number and arrangement there is therefore no difference from *H. papillosa*.

In the female, the tail is straight and gradually tapering, and measures 1.1–1.2 mm. in length. There is a conspicuous pair of caudal papillae at about 0.68 mm. from the posterior end. The vulva is situated very slightly behind the middle of the body (not in front of it, as stated by von Linstow), viz., at 3.7–4.75 mm. from the posterior end. The vagina is long, and pursues a complicated course almost precisely similar to that of *H. papillosa*. The terminal portion (ovjector) runs posteriorly from the opening. The tube then makes a sharp turn anteriorly, then a curve to the right and dorsally, then bends posteriorly, and from this point runs straight back to a point about 1.5 mm. from the anus. Here it doubles upon itself, and at about 1 mm. behind the vulva gives off the two apparently opposed uteri. The greater part of the coils of both ovaries lie in the anterior portion of the body, between the vulva and the posterior end of the oesophagus. The ova are somewhat oblong, with a thick shell, which is slightly dimpled at each pole.

They measure about 0.075×0.0425 mm.

Perhaps the most reliable character by which this form can be distinguished from *H. papillosa* is the larger size of the preanal sucker in the male—(outside diameter 0.06–0.07 mm. in *papillosa*, 0.08–0.09 mm. in *longicaudata*). The spicules are also a little longer, the right spicule being longer than that of any other species recorded in Galliform birds. The preanal sucker is, as a rule, situated somewhat nearer to the cloacal aperture than in *H. papillosa*, and the caudal alae of the male are broader. On placing examples of the two species side by side, the males are fairly readily separable, but it would be difficult to find characters by which the females could be easily distinguished.

Heterakis bosia, Lane, 1914.

This interesting form, the male of which is easily distinguished from that of other species by the peculiar shape of its left spicule, was found frequently in the crimson horned pheasant (*Tragopan satyra*). Although evidently common, it does not appear to give rise to heavy infections. It occurred once in association with *H. longicaudata* only, and once with both this species and *H. isolonche*.

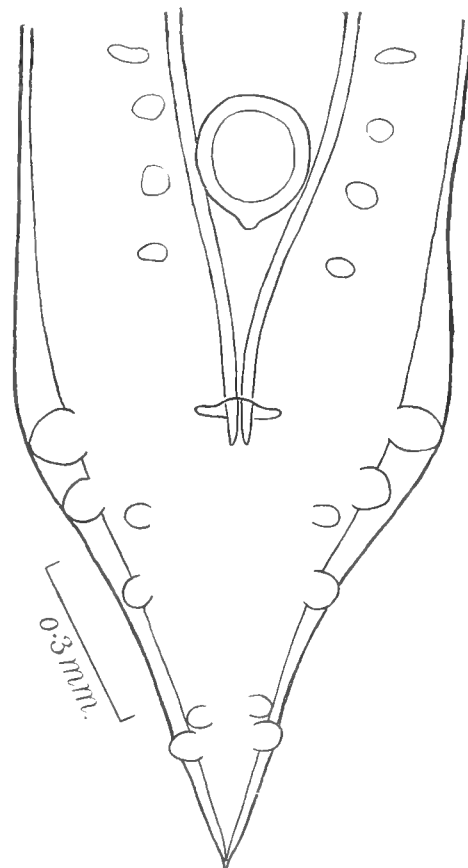


FIG. 25.—*Ascaridia perspicillum*. Tail of male; ventral view.

Genus *Ascaridia*, Duj., 1845.

Ascaridia perspicillum (Rud., 1803.)

(Fig. 25.)

Hosts:

Common fowl.

Blood pheasant (*Ithagene cruentus*).

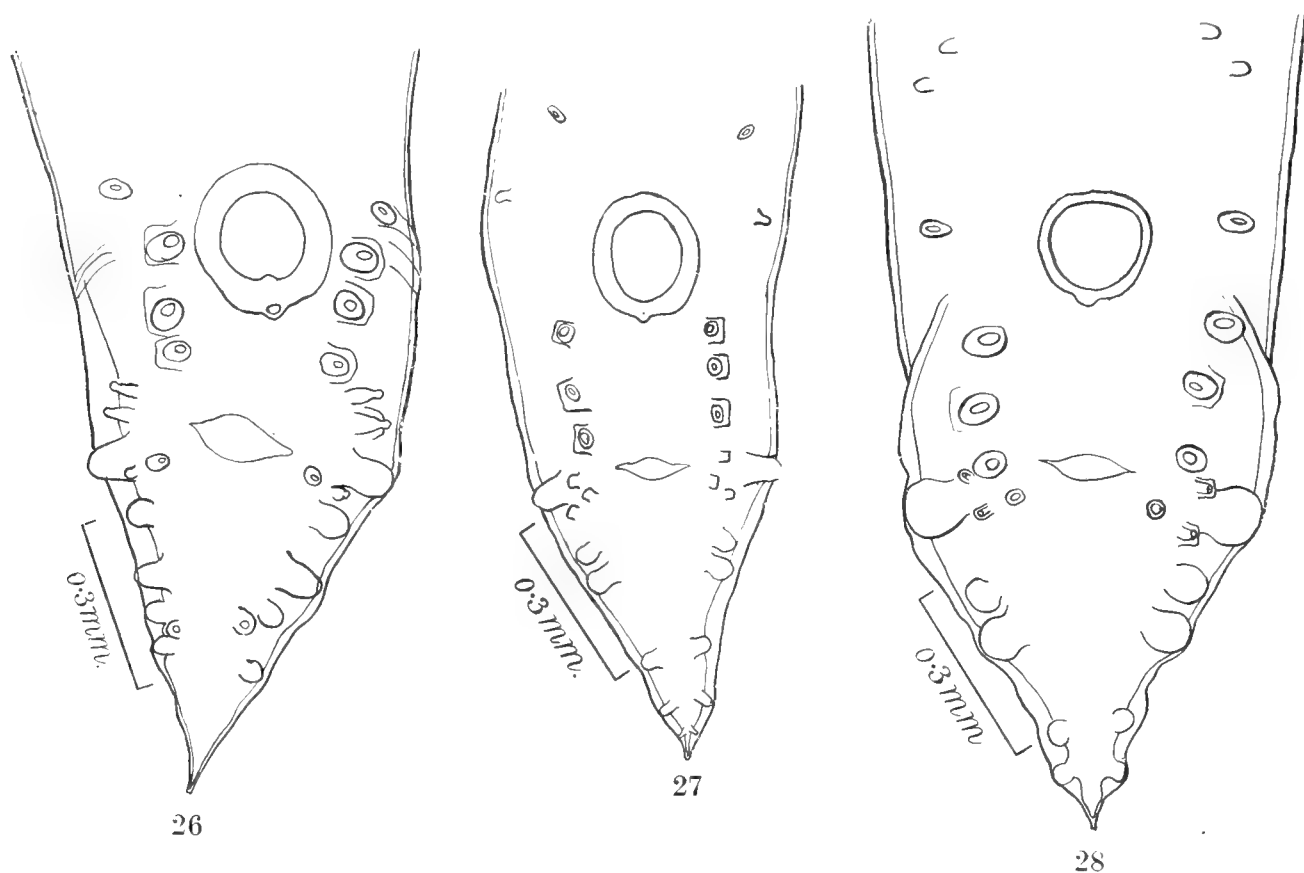
In view of the scarcity of figures of the male tail we furnish a new one (fig. 25).

Ascaridia columbae (Gmelin, 1790).

(Figs. 26-28.)

Syn. *Heterakis maculosa* (Rud., 1802), Schneider, 1866.

Specimens which we assign to this species were collected from the Bengal green pigeon (*Crocopus phoenicopterus*) on three occasions, and from *Phlogoenas luzonica* and other pigeons. Some difficulty was at first experienced in definitely determining these specimens, owing to the variations not infrequently encountered in the position and



FIGS. 26, 27, 28.—*Ascaridia columbae*. Tails of three males, in ventral view, to show variation in papillae.

number of the caudal papillae of the male. Actually the typical number of papillae is 14 pairs, which is the number given by von Linstow (1901 a), but the figure of this author is rather too diagrammatic to show clearly their arrangement.

There are five pairs of distinctly postanal papillae, the third pair of which is rather ventrally placed, while the remainder are lateral. There is an adanal group of

four pairs, one pair of which is large and laterally placed, the remaining three pairs being small and arranged in a triangle on the ventral surface. There is a series of three pairs of preanal papillae on the ventral surface between the cloaca and the posterior margin of the sucker. Near the level of the anterior margin of the sucker is another pair more laterally placed, and finally there is a pair placed anteriorly to the sucker. This last pair may be duplicated (fig. 28). Another variation may be furnished by the presence of an additional pair of papillae in the row between the sucker and the anus (fig. 26). Not infrequently also, the most posterior pair of postanal papillae appears to be absent (fig. 28). The spicules are equal and measure from 1.2 to 1.35 mm. in length.

An additional character of *A. columbae* which has, so far as we are aware, hitherto escaped notice, is the presence of 26 to 30 pairs of cervical papillae extending backwards from near the posterior end of the cephalic alae, the first two or three pairs being situated in the alae.

The species varies greatly in size, the males in our material measuring from 60 to 70 mm. in length and about 1.1 mm. in thickness; the females from 70 to 95 mm. and up to 2.5 mm. respectively.

***Ascaridia compar* (Schränk, 1790).**

(Fig. 29.)

This species has been recorded in *Caccabis saxatilis*, *Coturnix dactylisonans*, *Coturnix communis*, *Ortyx virginianus*, *Perdix cinerea*, *Tetrao urogallus*, *T. lagopus*, *T. tetrix*, *Gallus gallinaceus*, *Gallus domesticus*, *Numida meleagris*, and *Colinus virginianus*.

We have now to record its occurrence in the Chakor (*Caccabis chucar*).

The material agrees in all essential features with the descriptions given by v. Linstow (1899) and by Müller (1897), though the figures of the tail of the male given by both these authors are not quite accurate. Müller, indeed, describes the post-anal papillae correctly, but his figure fails to indicate clearly the number and arrangement of the small papillae near the tip of the tail. It may therefore not be out of place to give in the present paper a new figure (fig. 29).

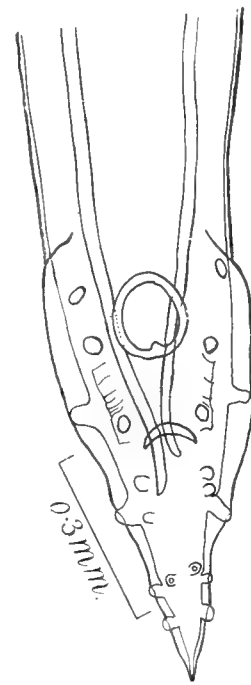


FIG. 29.—*Ascaridia compar*. Tail of male; ventral view.

***Ascaridia cristata* (von Linstow, 1901).**

(Fig. 30.)

This species was described by von Linstow from material taken from *Balearica regulorum*. We have to record its occurrence in the West African crowned crane (*Balearica pavonina**) and in the sarus (*Grus antigone*). We propose to amplify somewhat the original description.

The females measure from 38 to 40 mm. in length and 1.1 to 1.2 mm. in thickness; the males about 35 mm. and 1.1 mm. respectively. The head measures from

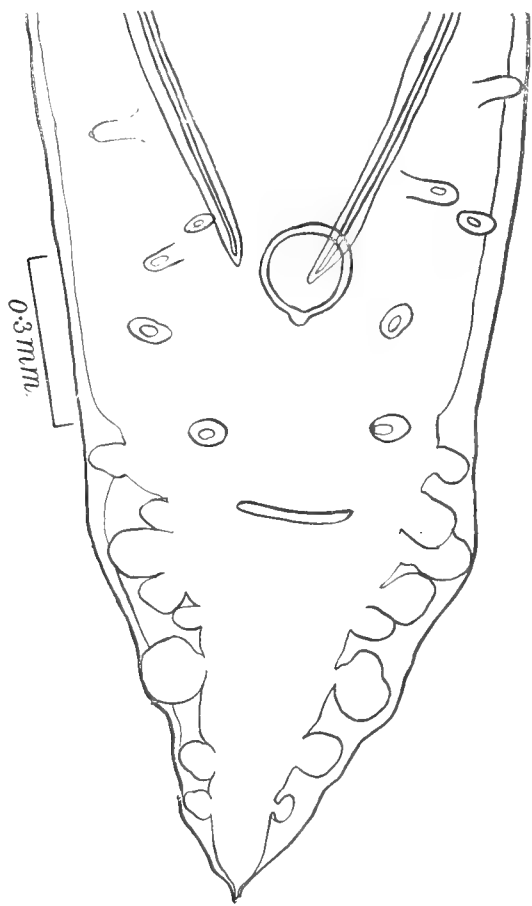


FIG. 30.—*Ascaridia cristata*. Tail of male; ventral view.

0.27 to 0.28 mm. in diameter. The dorsal lip is shorter and broader than the two ventro-lateral lips, and carries two papillae. The oesophagus measures from 2.1 to 2.3 mm. in length, and is encircled by the nerve-ring at a distance of 0.46 mm. from the head. The excretory pore opens at about 0.69 to 0.7 mm. from the anterior end. A series of 27 pairs of cervical papillae, similar to those described in *A. columbae* above, extends from a point about 0.9 mm. from the head backwards for a distance of 6.0 to 6.5 mm. The anterior pairs are placed just dorsally to the cervical alae, and the distance between successive pairs varies from 0.15 to 0.3 mm. The tail of the male is furnished with 13 pairs of papillae, of which 7 are postanal and 6 preanal. Von Linstow (1901 *b*) described 7 postanal pairs and 2 preanal, while Gedoelst (1916) in assigning specimens to this species describes 3 pairs of preanal papillae. The arrangement of the papillae in our material is shown

in fig. 30. Gedoelst also mentions that the sucker does not possess the "unpaired papilla" on its posterior border. In the specimens we have examined this structure was easily detected in some and in others apparently absent. The spicules are long and slender and measure 0.95 mm. in length and 0.042 mm. in width. They are alate. The anus is situated at about 0.62 mm. from the tip of the tail.

The vulva of the female is situated about 20 mm. from the anterior end, and is slightly salient. There is a short transverse vagina. The ova measure 0.085 × 0.058 mm. The tail measures 0.7 mm. in length.

***Ascaridia stroma* (von Linstow, 1899).**

Von Linstow described this species from *Grus paradisea*. The present collection furnishes us with specimens from the common crane (*Grus communis*) and the sarus (*Grus antigone*).

Genus **Strongyluris**, A. Müller, 1894.

Strongyluris chamaeleonis, sp. nov.

(Figs. 31-33.)

Host: *Chamaeleon vulgaris** (Zoological Garden, Calcutta).

This is a small species, measuring 6.3 mm. in length in the male, 8.4-8.75 mm. in

the female. The maximum thickness is 0.5–0.7 mm. The lateral fields are broad, and of the type characteristic of the genus, consisting of a single row of some 70 large, granular cells with clear, rounded nuclei. There are no lateral alae. No cervical papillae have been detected, nor do the longitudinal rows of small papillae on the body, which occur in some species, appear to be present in either sex. The cuticular striation is exceedingly fine. The diameter of the head is about 0.06 mm. There are three distinct lips, of somewhat elongate shape, each terminating anteriorly in a flattened lobe consisting only of cuticle, which, seen in profile (fig. 31), gives the lip the appearance of ending in a kind of curved tooth or spine. Each lip bears a relatively large papilla on the outer surface of its basal portion. The oesophagus, as has been observed in some other members of the genus, is marked off into a narrow anterior portion, or pharynx, the lumen of which describes a peculiar ventral bend posteriorly; and a wide posterior portion, the oesophagus proper, ending posteriorly in a well-developed bulb. The distance from the anterior extremity of the lips to the posterior end of the oesophageal bulb is about 1.1 mm. in the male, 1.45 mm. in the female. Of this the pharynx occupies 0.18–0.22 mm. The bulb is almost spherical, measuring 0.2–0.25 mm. in both antero-posterior and transverse directions. The nerve-ring is situated at 0.37–0.39 mm., and the excretory pore at 0.6–0.85 mm., from the anterior end.

The caudal end of the male (figs. 32, 33) is obliquely truncate, terminating in a small, conical spike. Anteriorly to this there are broad alae, forming an almost circular bursa-like expansion. Near the anterior limits of the alae there is a rounded sucker with chitinous ring, measuring 0.09 mm. in outside diameter, and having its aperture somewhat posteriorly directed. There is a little depression in the posterior edge of the chitinous ring, as in *Heterakis*. This has been described as a papilla in some species. The two equal spicules, which measure 1.1 mm. in length and 0.0275 mm. in maximum thickness, are covered externally with rather coarse granulations, and taper gradually from their bases to slender points. No chitinized accessory piece appears to be present. There are apparently nine pairs of caudal papillae, of which seven project more or less laterally into the alae, while two are situated ventrally behind the cloacal aperture. As only one male was available, and in this specimen the spicules were extruded, it is not certain whether any further ventral papillae may have been hidden from view by them. Of the laterally-placed papillae, two relatively small pairs are close to the tail-spike, the most posterior being directed more ventrally, the second more dorsally. The next two pairs are very close together and rather

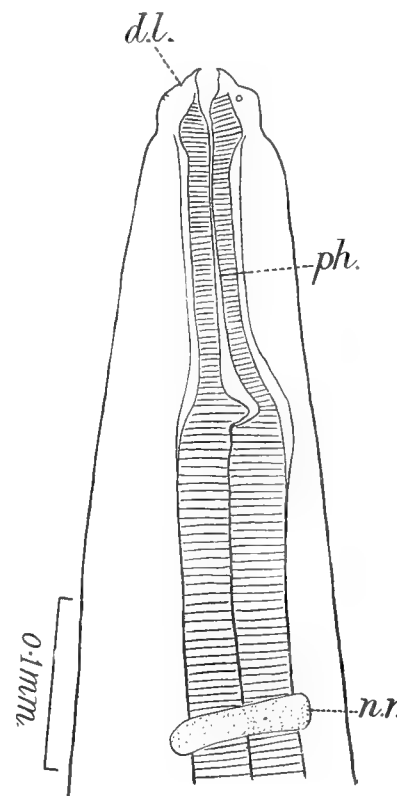


FIG. 31.—*Strongyluris chamaeleonis*. Anterior end of female; lateral view.

d.l., dorsal lip; n.r., nerve-ring; ph., pharynx.

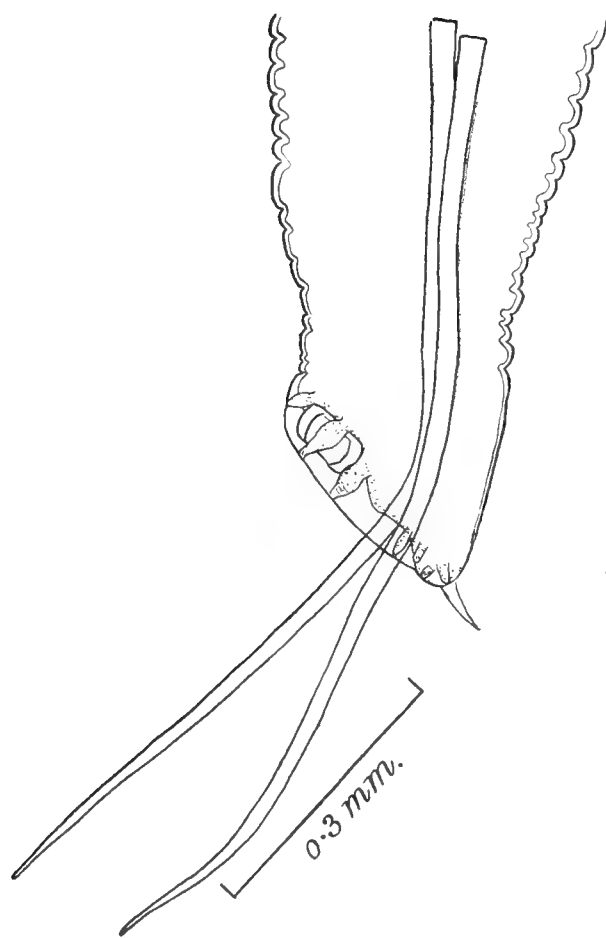


FIG. 32.—*Strongyluris chamaeleonis*. Posterior end of male; lateral view.

mm. When ready for laying the content of the egg is still unsegmented and coarsely granular.

Of the species referred to the genus *Strongyluris*, two, *S. sonsinoi* (v. Linst., 1894) and *S. elegans* (Gendré, 1909), occur in chamaeleons, the former in the same chamaeleon as the present species. *S. sonsinoi*, however, differs widely from our form, and from all others except *S. campanula* (v. Linst., 1899), in the elongate and conical shape of the tail in the male and in the possession of small, sessile, caudal papillae instead of the typical elongate, ray-like papillae. The present species is more closely related to *S. elegans*, but differs from it in its smaller size and the much longer spicules of the male, besides other details; and we are equally unable to identify it with any of the known species parasitic in lizards.

As regards the systematic position of *Strongyluris*, Seurat (1917), in opposition to the view taken by most authors,

slender. The remaining three pairs form a group on either side of the sucker, decreasing in size from behind forwards. The most posterior of these three pairs is very massive. The length of the tail (i.e., from the cloaca to the posterior extremity) is about 0.13 mm., of which the terminal spike measures 0.06 mm.

In the female the short, conical tail measures 0.3 mm. in length, and bears a pair of small papillae at 0.14 mm. from the tip. The vulva is situated at 3.0–3.3 mm. from the posterior end. The vagina is long, slender, and pursues a rather tortuous course, the general direction of which is posterior from the vulva. The branches of the uterus are parallel, running at first posteriorly to within a short distance of the anus, then returning towards the anterior end. The coils of the ovaries are situated in the anterior half of the body. The eggs are oval, with a thick shell, slightly flattened externally and thickened internally at each pole. They measure about 0.0875×0.055

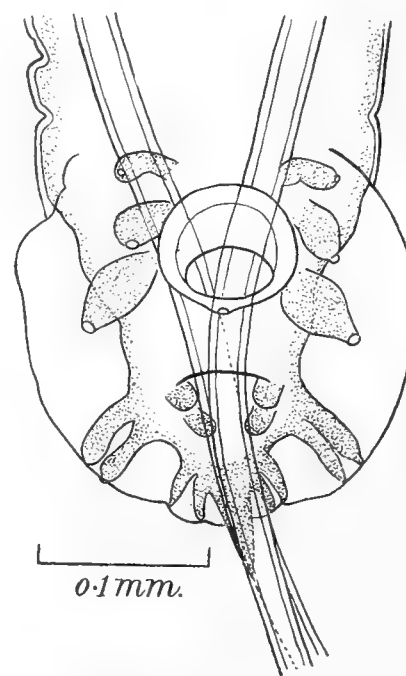


FIG. 33.—*Strongyluris chamaeleonis*. Posterior end of male; ventral view.

regards it as related rather to the Oxyuridae than to the Heterakidae. His contention is based chiefly on the characters of the lateral fields and of the body-muscles. The other points mentioned (presence of lateral alae on the body, absence of caudal alae in the male), are clearly not universal characters of *Strongyluris* as at present constituted. On the other hand, the structure of the preanal sucker, which is exactly similar to that of *Heterakis*, is a character probably quite as important as the lateral fields; while the arrangement of the musculature does not appear in all cases to be a reliable guide to classification. Travassos, in a recent paper (1920 [?]) has suggested placing *Strongyluris* in a new subfamily, Spinicaudinae, of the Heterakidae. Railliet and Henry (1914), regarded it as a subgenus of *Heterakis*. We prefer to treat it as a genus, with close relationships to *Heterakis*, and reserve judgment on the question of including it in a separate subfamily. The following tabular arrangement of the species shows that there are two well-marked groups within the genus as hitherto constituted, these groups being characterized chiefly by the presence or absence of caudal alae in the male.

A. Tail of male without alae.

a. Tail long, straight and tapering. An accessory piece present.

S. sonsinoi (v. Linst., 1894).

S. campanula (v. Linst., 1899).

b. Tail obliquely truncate ventrally, but with an elongate terminal cone. An accessory piece present.

S. icosiensis, Seurat, 1917.

B. Tail of male with bursa-like alae and obliquely truncate. Accessory piece absent.

S. brevicaudata, Müller, 1894.

S. paronai (Stossich, 1902).

S. elegans (Gendré, 1909).

S. chamaeleonis, sp. nov.

S. ornata (v. Linst., 1897) and *S. streptoesophageus*, Connal, 1912, are probably synonymous with *S. brevicaudata*.

It seems justifiable to restrict *Strongyluris* to the forms (B) which agree with its genotype, *S. brevicaudata*, in the characters mentioned; while we propose to erect a new genus, *Sonsinia*, to include the non-alate forms, with *S. sonsinoi* as genotype. *S. icosiensis* appears to occupy a somewhat intermediate position, but for the present may be referred to *Sonsinia*.

Genus **Pseudaspidodera**, nov.

Pseudaspidodera pavonis, sp. nov.

(Figs. 34-37.)

Hosts: Burmese peafowl (*Pavo muticus*) and "white peafowl" (*Pavo cristatus*).

This is a small worm, the male measuring about 6 mm. in length, the female 7 mm. The greatest thickness is about 0.25 mm. in the male, 0.3 mm. in the female. The cuticular striations, if present, are too fine to measure. The head (fig. 34) is ornamented with "cordons" resembling those of *Aspidodera*, opening in pairs at the interlabial spaces, and consisting of tubular grooves running below the surface of the cuticle, with a narrow external opening along their length. The members of each pair of cordons diverge at once and, after running back for a short distance, turn forward, each on to the outer surface of one of the three lips, where, instead of joining the corresponding member of the next pair, as in *Aspidodera*, it ends separately. The diameter of the head at the posterior limit of the cordons is about 0.1 mm. Narrow

lateral alae run down the body from a little in front of the nerve-ring nearly as far as the tail. The oesophagus is muscular throughout, 1.4–1.48 mm. long in the male, 1.5–1.6 mm. in the female. It is divided a little behind the head into a very short anterior portion, and a long posterior portion which ends in a well-developed pyriform

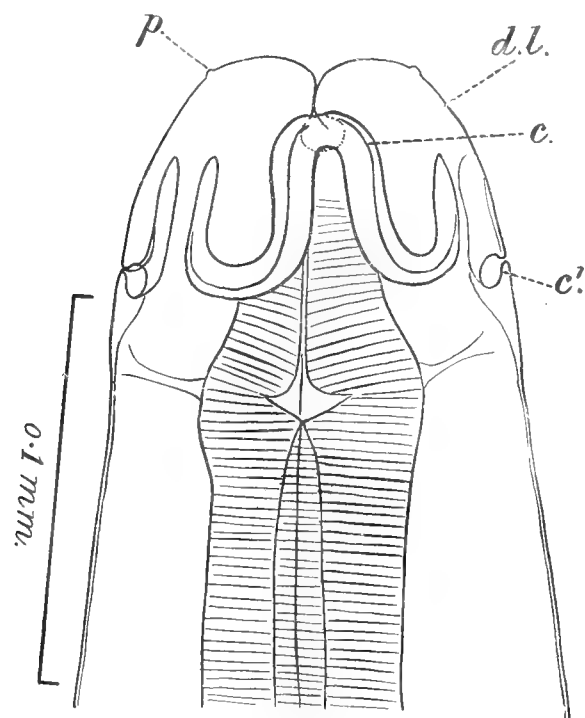


FIG. 34.—*Pseudaspidodera pavonis*. Head of female; lateral view.

c., cordon; c', optical section of same; d.l., dorsal lip; p., papilla.

bulb. At the division of these two portions there appears to be some kind of valvular apparatus. The bulb measures 0.25–0.26 mm. in length and 0.17–0.19 mm. in diameter transversely, and contains the usual valves. The nerve-ring is situated at 0.4–0.46 mm., and the excretory pore at 0.6–0.65 mm., from the anterior extremity.

In the male, the tail (figs. 35, 36) which is 0.38–0.43 mm. long, is provided, for rather less than the anterior half of its length, with wide alar expansions, into which some of the caudal papillae project. The remainder of the tail is simple and slender, ending in a fine, tapering point. There is a circular preanal sucker, 0.12–0.13 mm. in diameter, with well-developed chitinous wall, situated at 0.15–0.17 mm. in front of the cloaca. The greatest diameter (antero-posterior) of the opening of the sucker is about 0.07 mm. The two

spicules are very unequal and dissimilar. The right spicule is slender and simple, measuring 0.78 mm. in length. The left is provided with broad alae at the sides, has a barbed tip, and is only 0.45 mm. long. There is no accessory piece. There are twelve pairs of caudal papillae, the arrangement of which can be understood most readily by reference to the figures. Three pairs, of which the middle pair is more ventrally situated and slightly larger than the others, form a group just in front of the filamentous portion of the tail. The fourth pair is solitary, projecting laterally into the alae. There is an adanal cluster of papillae consisting of four more or less lateral pairs with long stalks, and two small, sessile, ventral pairs, one in front of and one behind the cloaca. Of the four lateral pairs the most posterior is the stoutest, and projects laterally. The next is more ventrally directed. The next is again lateral; while the most anterior of the group projects ventrally. There are two very slender and long-stalked papillae on either side of the sucker.

In the female the tail is long and straight, tapering to a slender point. It measures 1.0–1.02 mm. At about the middle of its length there is a very minute pair of caudal papillae. The vulva is situated behind the middle of the body, at about 3 mm. from the posterior end. It leads into a vagina (fig. 37) which is convoluted in a characteristic manner—running forward at first, as a strongly muscular ovejector, it curls first in a semicircle so as to return towards the body-wall on the ventral side.

Then, taking a turn to the right, and dorsally again, it doubles back upon itself. On reaching a point just behind the level of the vulva the character of the walls changes,

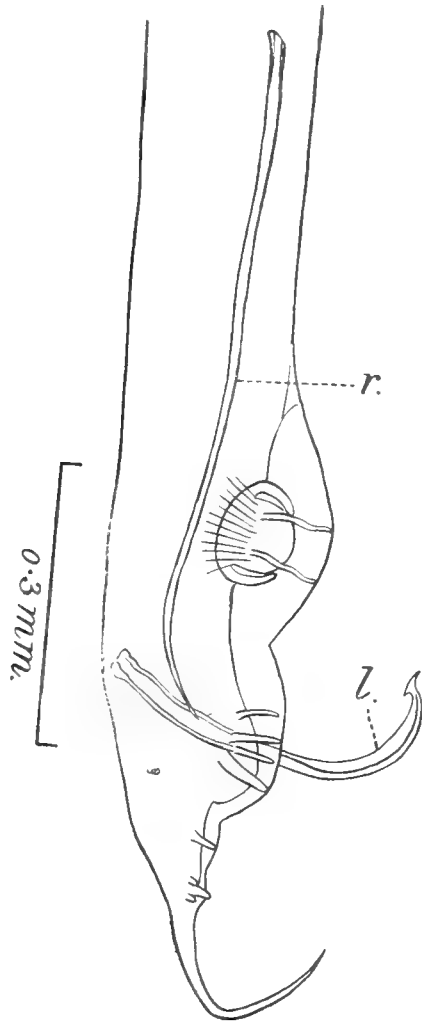


FIG. 35.—*Pseudaspidoidea pavonis*.
Posterior end of male; lateral view.
l., left spicule; *r.*, right spicule.

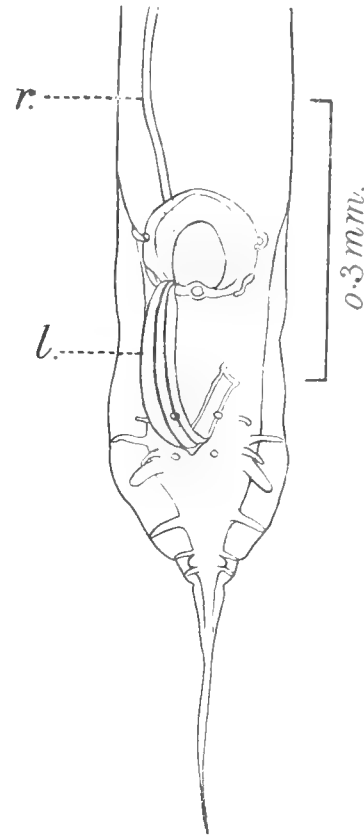


FIG. 36.—*Pseudaspidoidea pavonis*.
Posterior end of male; ventral view.
l., left spicule (protruded); *r.*,
right spicule.

the circular coat of muscles being much less strongly developed. The tube runs back from this point quite straight to a distance of about 0.8 mm. behind the vulva. Here it doubles upon itself again, and at about 0.15 mm. behind the vulva gives off the two opposed uteri. As in *Heterakis*, the two oviducts, doubling upon themselves in the anterior and posterior halves of the body respectively, return and cross each other so that the coils of the ovary belonging to the anterior uterus are disposed in the posterior half of the body, and those of the other ovary in the anterior half. The ova are relatively large, of somewhat oblong shape, with a thin

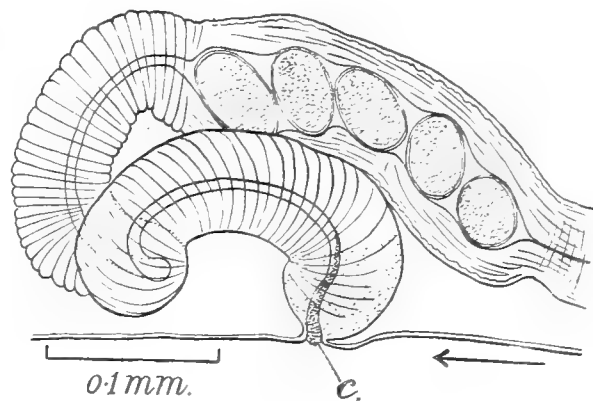


FIG. 37.—*Pseudaspidoidea pavonis*. Vulva and
vagina of female, in lateral view.
c., plug of cement in vulva. The arrow points in the
direction of the head.

shell measuring about 0.07×0.04 mm., and usually showing a slight internal thickening at one pole. One end of the shell, as seen *in utero*, is occasionally drawn out almost to a point. The content of the egg is unsegmented at the time of laying.

The characters of this form are such that it appears to form a link between the genera *Heterakis* and *Aspidodera*. It has cephalic "cordons" similar to, but rather less highly-developed than, those of *Aspidodera*; while it possesses long, pedunculate caudal papillae in the male, like those of *Heterakis* in shape and arrangement, and unlike the more sessile papillae of *Aspidodera*. The markedly dissimilar spicules and the absence of an accessory piece are also characters of *Heterakis* rather than of *Aspidodera*.

Two species of *Heterakis* have been recorded in peafowl—*H. papillosa* (Bloch) and *H. hamulus*, v. Linst., 1906. The former is, of course, a well-known species and the genotype of *Heterakis*. Although the description of *H. hamulus* is rather brief, it appears sufficient to prevent the identification of the present form with that species.

Subfamily *SUBULURINAE*, Travassos, 1914.

Genus *Subulura*, Molin, 1860.

Subulura sarasinorum (Meyer, 1896).

This species occurred in the intestine of a slender loris (*Loris gracilis*)¹ in the Calcutta Zoological Garden.

Subulura galloperdicis, sp. nov.

(Fig. 38.)

This species was collected from the intestine of the Red spur-fowl (*Galloperdix spadicea*).

The female measures 11.5 to 12.5 mm. in length and about 0.4 mm. in thickness; the male 9.5 to 10 mm. and 0.3 mm. respectively. The head is small, measuring about 0.08 mm. in diameter. There are narrow cephalic alae which extend to a distance of about 1 mm. from the anterior end. The buccal cavity is 0.06 mm. deep, about 0.023 mm. wide at the anterior end, and 0.031 mm. at the posterior end. There are three triangular teeth at the base of the buccal cavity, two sub-dorsal, and one ventral and median. The height of the teeth is about 0.013 mm. The nerve-ring is situated at 0.27 mm. from the head, whilst the excretory pore opens on the ventral surface at 0.45 mm. from the head. The oesophagus consists of a long muscular portion with the usual prebulbar swelling, and a large bulb containing the grinding apparatus. The anterior portion is 1.5 mm. in length, and the prebulbar swelling 0.14 mm. in thickness. The bulb is roughly spherical and has a diameter of 0.2 mm. The vulva is situated in the anterior half of the body, dividing the latter in the ratio of 3 : 4. There is a short transverse vagina from which large, well-developed ovejectors run anteriorly and posteriorly. The ovaries commence at the anterior and posterior bends of the uteri, and terminate in the vicinity of the vulva. The bend of the anterior genital tube is at about 0.42 mm. from the oesophageal bulb, while that of the posterior is at about 0.22 mm. from the tip of the tail. The ova measure

¹ Now called *Loris lydekkerianus*.

0.065 × 0.035 mm. and contain fully-formed embryos. The anus is situated at 1.1 mm. from the tip of the tail.

The tail of the male (fig. 38) measures 0.21 mm. in length and is drawn out at the tip into a fine point. There are eleven pairs of papillae, four pairs of which are preanal, two adanal, and five postanal. The sucker is situated at about 0.65 mm. in front of the anus, and is spindle-shaped. Of the preanal papillae a latero-ventral pair is situated on the lateral border of the sucker and towards its anterior margin: variation in the position of this pair is not uncommon. The remaining three pairs are placed between the sucker and the anus. The anterior of these is laterally placed at about 0.15 mm. behind the sucker. The next two pairs are ventral, one being about 0.07 mm. behind the preceding pair, and the other just anterior to the adanal

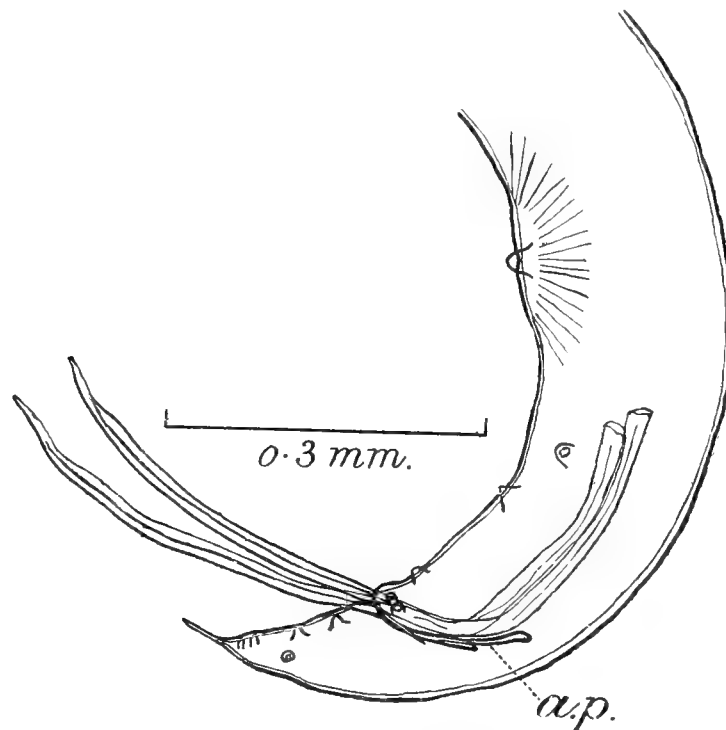


FIG. 38.—*Subulura galloperdicis*. Posterior end of male; lateral view.
a.p., accessory piece.

papillae. The two pairs of adanal papillae are placed on the anterior border of the cloaca, one lateral to the other. Of the postanal papillae, the third pair is quite lateral, the remaining four pairs ventral. The first and second pairs are small and close to the tip of the tail. The fifth pair is immediately posterior to the anus, and the fourth pair is a little less than half-way between the second and fifth pairs. The third pair, which is lateral, is situated about midway between the anus and the tip of the tail.

The spicules are equal, long and slender. They measure from 0.76 to 0.8 mm. in length, and are tapered to a fine but rounded point. They consist of a cylindrical axis, which measures about 0.011 mm. in diameter, and two alae. Their total width is about 0.02 mm. The edges of the alae are very finely serrated. There is an

accessory piece (fig. 38, a.p.), which is slender and curved. It measures about 0.18 mm. in length and has a spur at about 0.06 mm. from its anterior end.

The male genital tube is much coiled and reaches to within 0.7 mm. of the oesophageal bulb.

The number and disposition of the caudal papillae in the male, the length of the spicules and accessory piece and the position of the vulva in the female are salient characters which serve to distinguish *Subulura galloperdicis* from the other members of this genus occurring in galliform birds.

There are five members of this group which possess eleven pairs of papillae, viz., *S. curvata* (v. Linst., 1883), *S. strongylina* (Rud. 1819), *S. olympioi*, Barreto, 1919,¹ *S. halli*, Barreto, 1919¹ and *S. seurati*, Barreto, 1919.¹

S. curvata has unequal spicules measuring 1.2 and 0.9 mm. respectively, and the papillae are made up as follows:—2 pairs preanal, 2 adanal, and 7 postanal. *S. strongylina* possesses a chitinous tail appendage. The papillae consist of 3 preanal, 2 adanal, and 6 postanal pairs. The spicules measure 0.899 mm. in length. *S. olympioi* has 3 pairs of preanal, two pairs of adanal and six pairs of postanal papillae. *S. halli* has five pairs of preanal papillae; and the spicules measure 1.5 mm. in length. In *S. seurati* the spicules are unequal and there are 5 pairs of preanal papillae, while the vulva is situated at the junction of the anterior and middle thirds of the body.

Subulura, sp.

The collection contains two females of a species of *Subulura* taken from the Button-Quail (*Turnix*, sp.) One of the specimens is badly damaged. The complete specimen measures 14 mm. in length and 0.41 mm. in thickness. The head measures about 0.08 mm. in diameter. The buccal capsule is 0.035 mm. deep and 0.02 mm. wide. The usual teeth are present.

Narrow cephalic alae extend as far as the beginning of the prebulbar oesophageal swelling. The total length of the oesophagus is 1.1 mm., while the diameter of the bulb, which is roughly spherical, is 0.15 mm. The nerve-ring encircles the oesophagus at 0.1 mm. from the anterior end. The excretory pore opens at 0.4 mm. from the head in the median ventral line. The anus is situated at 0.32 mm. from the tip of the tail, which is acutely pointed. The vulva is situated at 6.1 mm. from the anterior end. The posteriorly-directed vagina is just discernible. For the rest the body of the worm is completely filled with eggs, reaching anteriorly up to within 0.07 mm. of the anterior end, and posteriorly to within 0.1 mm. of the tip of the tail. The eggs are in various stages of development, some containing fully-formed embryos. They are thin-shelled and measure 0.085 × 0.056 mm.

It is not possible to assign these specimens to a definite species.

Family OXYURIDAE, Cobbold, 1864.

Genus **Oxyuris**, Rud., 1803.

Oxyuris anthropopithecii, Geddoelst, 1916 (?).

Host: Black-headed lemur * (probably *Lemur brunneus*).

¹ In Barreto's (1919) monograph of the subfamily Subulurinae, these species are given as "*S. olympioi*, Barreto, 1918," "*S. halli*, Barreto, 1917" and "*S. seurati*, Barreto, 1917." The names, however, do not appear to have been published previously to 1919, although the work was in preparation in 1917.

No *Oxyuris* appears to have been recorded in true lemurs, though two forms, *O. corollatus*, Schneider, 1866 and *O. coronata*, v. Linst., 1903, are recorded in *Galeopithecus*. It is impossible to identify the present material with either of these, both of which have characteristic spinous structures on or near the head. Of the forms found in apes and monkeys, the nearest appears to be *O. anthropopithecii*, from the chimpanzee. Both Gedoelst's material and our own has unfortunately consisted only of females, so that the characters available for determination are scanty, and we have been compelled to rely chiefly on measurements. While, therefore, we find a fairly close agreement between our material and Gedoelst's (1916) description, the determination, especially in view of the difference of hosts, can only be regarded as tentative.

***Oxyuris compar*, Leidy, 1856 (?).**

A single female, from the intestine of a domestic cat in Calcutta, is doubtfully referred to this little-known and apparently rare species.

Genus ***Atractis***, Duj., 1845.

Atractis dactylura (Rud., 1819).

Examples of this species, all young females, occurred in association with *Zanclophorus kempi* (see p. 312) in the intestine of *Testudo elongata* at Baradighi, Jalpaiguri, Bengal.

***Atractis opeatura*, Leidy, 1891.**

Syn. *A. cruciata*, v. Linst., 1902.

This form occurred in large numbers in the intestine of an iguana* (species not mentioned) in the Zoological Garden, Calcutta. Unfortunately, the specimens are in rather poor condition and not quite mature. They show no important differences from the descriptions furnished by von Linstow ((1901 *a*) and (1902)) and by Railliet and Henry (1912), except that there is an additional pair of small caudal papillae, adanal in position, in the male.

Note.—Travassos (1920 [?]) proposes a family Atractidae, which he considers to belong to the superfamily Rhabdiasoidea (= Angiostomoidea). The included genera are *Atractis*, *Ozolaimus*, *Rondonia*, *Labiduris*, *Crossocephalus*, *Macracis*, *Cobboldina* and *Cyrtosomum*. These are, for the most part, little-known forms, and in the present unsatisfactory state of our knowledge of the Oxyuridae as a family, and in the absence of a definition of the family Atractidae, we prefer to adopt a conservative attitude as to the position of *Atractis*. The whole question of the relationships of the Angiostomoidea (or Rhabdiasoidea) is much involved at present; but it may be remarked, in passing, that the definition of the Angiostomoidea is based mainly on the fact that its species have two heterogenetic generations, and the parasitic phase is without males. This is not known to be the case with the forms included in Travassos' proposed family, though in *Atractis dactylura* an alternation of generations of a different kind is said to occur (Macé, 1887). Here the females of the parasitic phase are viviparous, and the generation to which they give rise is said to consist entirely of oviparous females.

Family **KATHLANIDAE**, Travassos, 1918.

Genus ***Falcaustra***, Lane, 1915.

The collection includes examples of four species of this genus, all of which appear to be new. The following known species have been assigned to the genus up to the present:

F. falcata (v. Linst., 1906), from *Geoemyda trijuga*,
F. lambdiensis, Seurat, 1918, from *Clemmys leprosa*,
F. siamensis, Baylis, 1920, from *Hieremys annandalei*;

while we may also refer to it

F. [Oxysoma] kachugae (Stewart, 1914), from *Kachuga lineata*.

The hosts of all these species are tortoises. Of the new species to be described, two are from tortoises and two from a fish. Some of them show considerable divergence from the typical characters, and will necessitate some modification of the generic diagnosis. We do not, however, feel justified in splitting up the genus at present, as it would be hard to find a clear and satisfactory dividing-line between the typical and the atypical species.

Taking first the forms that depart least from the characters of the genotype, we have the following:—

***Falcaustra testudinis*, sp. nov.**

(Fig. 39.)

Host: *Testudo elongata*. Locality: Assam (Tura, foot of Garo Hills).

This is the smallest species hitherto met with. The male measures 10.2–10.4 mm. in length and 0.6 mm. in thickness; the female 9.2–11.5 mm. and 0.6–0.75 mm. respectively. The diameter of the head is 0.15–0.16 mm. This is followed by a slightly narrower neck. The buccal cavity measures about 0.05 mm. in length and

0.03 mm. in diameter. The distinct anterior division of the oesophagus, to which we shall hereafter refer as the “pharynx,” is 0.13–0.14 mm. long. The entire oesophagus, from the extremity of the head to the back of the bulb, measures 1.7–2.1 mm. The bulb consists of two swellings separated by a narrow neck; its length is 0.4–0.45 mm. and the diameter of the larger (posterior) swelling 0.26–0.27 mm. The prominent cervical papillae are situated at 1.03–1.1 mm., the nerve-ring at 0.44–0.45 mm., and the excretory pore at 1.22–1.26 mm., from the anterior end.

In the male the tail is 0.81 mm. long, and there is no preanal sucker-like organ.

The caudal papillae (fig. 39) consist of the typical eleven pairs and one unpaired preanal papilla. Nos. 1 and 2 are close together, ventral; No. 3 lateral; No. 4 isolated, ventral; No. 5 ventral; No. 6 lateral, at about the same level as No. 5; Nos. 7 and 8 at the sides of the cloaca and close together. The spicules measure 0.8 mm. in length and 0.07 mm. in greatest width. The chitinized portion of the accessory piece is 0.15–0.17 mm. long.

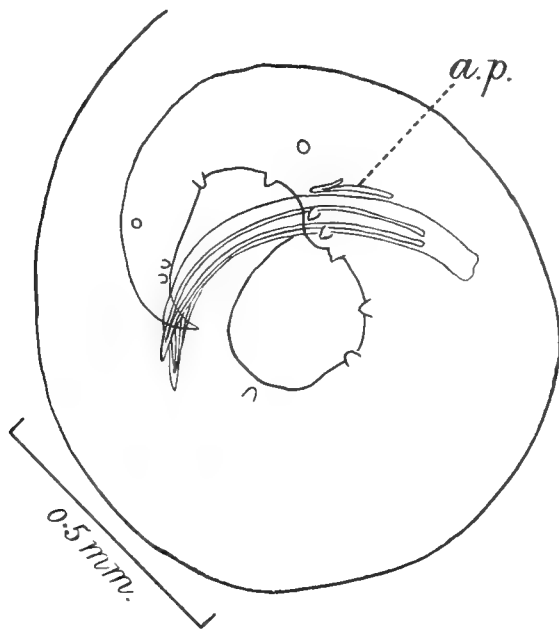


FIG. 39.—*Falcaustra testudinis*.—Posterior end of male; lateral view.

a.p., accessory piece.

In the female the tail is about 1 mm. long, and the caudal papillae are at 0.5 mm. from the tip. The vulva is situated at 3.9–4.7 mm. from the posterior end. The vagina is long, running forward for a distance of 2.3 mm. before giving off the uterine branches. The eggs measure $0.125-0.137 \times 0.075-0.087$ mm.

***Falcaustra barbi*, sp. nov.**

(Figs. 40, 41.)

Host: Mahseer (*Barbus tor*). Locality: Torsa River, Falakata, Eastern Bengal.

This species measures 15.2–16.5 mm. \times 0.65–0.7 mm. in the male; 15.5–19.6 mm. \times 0.65–1.0 mm. in the female. The cuticular striations, if present, are excessively fine. The almost globular head has a diameter of 0.2–0.22 mm., and is followed by a distinct neck. The buccal cavity measures about 0.07 mm. in length, the pharynx 0.1 mm. The distance from the anterior end to the end of the oesophagus, including the bulb, is 2.5–2.8 mm. The anterior swelling of the bulb is oval in shape and sharply constricted off from both the preceding portion of the oesophagus and the rest of the bulb. The dimensions of the bulb are 0.5–0.59 mm. in length and 0.34–

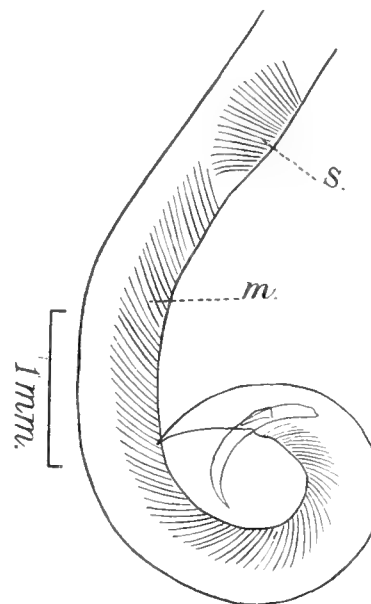


FIG. 40.—*Falcaustra barbi*. Posterior end of male; lateral view.

m., caudal muscles; *s.*, sucker-like organ.

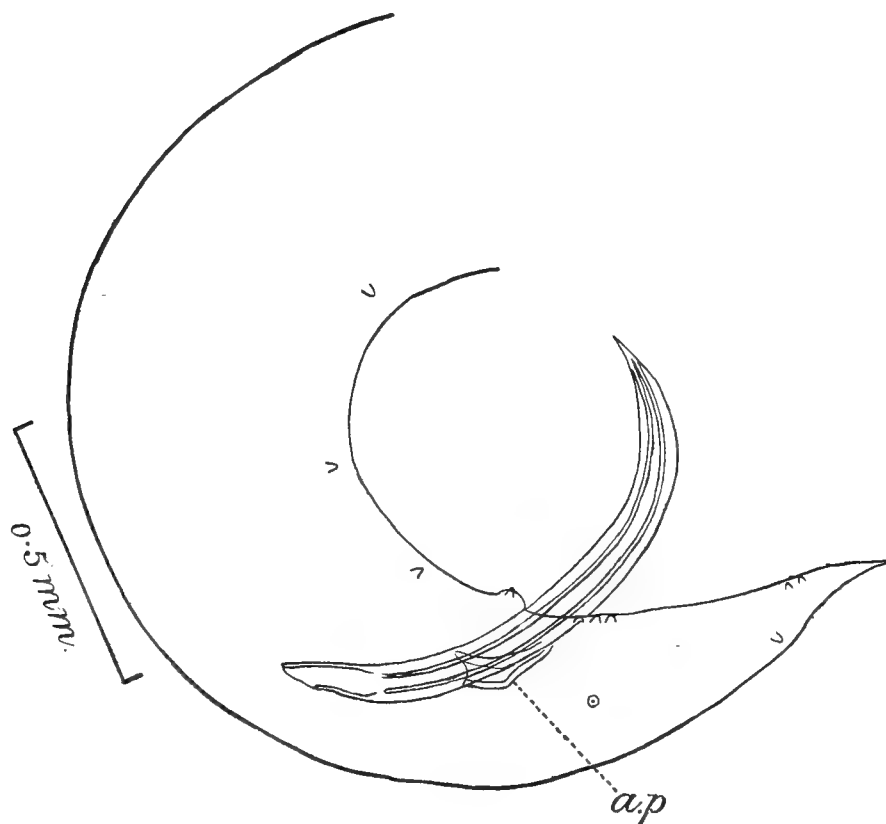


FIG. 41.—*Falcaustra barbi*. Tail of male; lateral view.

a.p., accessory piece.

0.37 mm. in diameter. The small, but prominent, cervical papillae are situated at 1.2–1.4 mm., the nerve-ring at 0.4–0.5 mm., and the excretory pore at 1.55–1.9 mm., from the anterior end.

The tail of the male is about 0.6 mm. long. There is a single preanal, sucker-like, fan-shaped aggregation of muscles, situated in front of the long series of oblique caudal muscles (fig. 40). The caudal papillae (fig. 41) are very small and inconspicuous. There are ten pairs and an unpaired preanal papilla. Of the postanal papillae Nos. 1 and 2 are close together and ventral; No. 3 lateral. There are three more pairs close together and ventral, and one lateral, just behind the cloaca. The spicules are 1.13 mm. long, and 0.1 mm. wide dorso-ventrally at the widest part, which is near the root. The accessory piece is well-chitinized, and measures 0.2 mm. in length.

The tail of the female is 0.65–0.8 mm. long, and carries a pair of inconspicuous papillae at 0.35 mm. from the tip. The vulva is situated at 6.25–7.3 mm. from the posterior end. The vagina is short (about 1 mm.) and nearly straight. The eggs are roundish oval, and measure about 0.075 × 0.05 mm.

The intestine of every specimen examined contained large numbers of diatoms.

Falcaustra leptcephala, sp. nov.

(Fig. 42.)

Host: Mahseer (*Barbus tor*). Locality: Torsa River, Falakata, Eastern Bengal.

This species occurred together with the preceding, in large numbers, in the same fish. It is easily distinguished from *F. barbi* by its very narrow head and the absence of a neck. It is a large, stout form, especially as regards the females. These appear an opaque white in spirit, owing to the large numbers of eggs in the uterus. The males, in spirit, remain semi-transparent. In both sexes the intestine shows through the body-wall as a blackish line, and this may be partly due to the fact that its contents, as in the case of *F. barbi*, consist very largely of diatoms.

The male measures up to 19 mm. in length and 1.3 mm. in thickness; the female up to 27 mm. and 1.4–1.8 mm. respectively. The cuticular striations are about 0.002 mm. apart. The diame-

FIG. 42.—*Falcaustra leptcephala*. Tail of male; lateral view.

ter of the head is 0.1–0.12 mm. The buccal cavity is about 0.05–0.06 mm. long, the pharynx 0.14–0.17 mm. The whole oesophagus, from the head end to the back of the bulb, measures up to 3.5 mm. The bulb is flask-shaped, having no sharp

constriction between the two swellings. Its length is 0.6–0.67 mm., and the diameter of the posterior swelling 0.45–0.47 mm. The prominent, almost bristle-like, cervical papillae are situated at 1.3–1.4 mm., the nerve-ring at 0.45–0.5 mm., and the excretory pore at 2.0–2.15 mm., from the anterior end.

The tail of the male (fig. 42) measures 0.7–0.85 mm. in length. There is no pre-anal sucker-like organ. The number and arrangement of the papillae are the same as in the preceding species (*F. barbi*)—there being ten pairs and a median preanal papilla. The spicules are about 1 mm. long and 0.09 mm. wide. There appears to be no chitinized accessory piece.

In the female the tail is 1.1–1.3 mm. long. The caudal papillae are very inconspicuous, and are situated at 0.6 mm. from the tip. The vulva is at about 11 mm. from the posterior end. The vagina is narrow, and apparently short, but its course is difficult to trace owing to the dense masses of ova in the uterus. It runs forward and dorsally from the vulva, keeping close to the body-wall. The branches of the uterus are wide, nearly filling the body-cavity. The ova are very much more numerous and considerably smaller than in most of the other species, and of a much more spherical shape. They measure 0.075 × 0.055 mm., and their contents appear to be unsegmented at the time of laying.

***Falcaustra stewarti*, sp. nov.**

(Figs. 43, 44.)

Hosts and localities:

Kachuga smithii; Ferozpore, Punjab.

Hardella thurgi; Siripur, Saran, Bihar.

This is a species of moderate size, differing from the typical forms in having a larger number of caudal papillae in the male, and in other features. In the material from *Kachuga smithii*, which we take as typical, the length of the male is 17–19.8 mm., that of the female 19–22.6 mm. The greatest thickness is 0.6–0.7 mm. in the male; 0.65–0.75 mm. in the female. The cuticular striation is exceedingly fine. The head has a diameter of 0.19–0.21 mm., and is followed immediately by a slightly narrower neck. The buccal cavity is very shallow, measuring only 0.06 mm. in length. A distinct pharynx is present, 0.09 mm. long. The total length of the oesophagus is 2.1–2.5 mm. The bulb has no marked constriction, and measures 0.5–0.55 mm. in length and 0.3–0.32 mm. in diameter. The small, but very prominent, cervical papillae are at 1.3–1.37 mm., the nerve-ring at 0.5–0.6

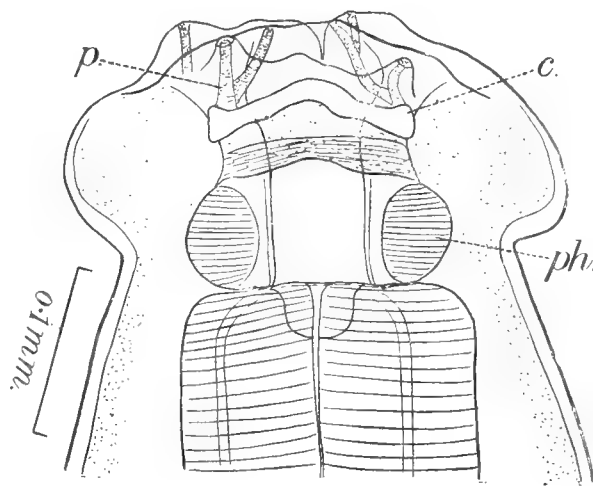


FIG. 43.—*Falcaustra stewarti*. Head of female from *Hardella thurgi*; dorsal view.

c., cuticular ring; p., forked pulp of papillae; ph., pharynx.

mm., and the excretory pore at 1.6–1.65 mm. (male), or 1.75–1.85 mm. (female), from the anterior end.

The tail of the male (fig. 44) is 1.4–1.7 mm. long, and tapers to a slender point. There is no preanal sucker-like organ, but the oblique caudal muscles are well-developed. There are 16–18 pairs of caudal papillae and one median, unpaired papilla, the latter and three pairs being, as usual, preanal. Of the postanal papillae two pairs are lateral, the rest ventral. Occasionally one or two of the anterior ventral pairs become adanal in position. The members of the more posterior pairs sometimes become displaced anteriorly or posteriorly, so as to disturb the symmetry of the paired arrangement. The spicules are short (0.5 mm.) and have a maximum width of 0.09 mm. A vaguely-defined mass of imperfectly chitinized tissue represents the accessory piece, and a fan-shaped bundle of muscles extends from it to the dorsal body-wall.

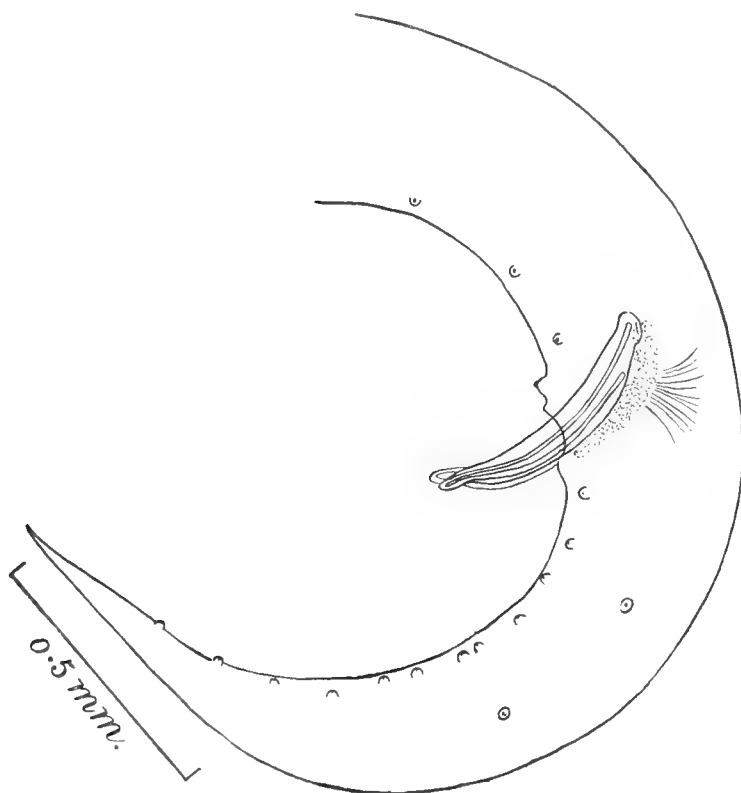


FIG. 44.—*Falcaustra stewarti*. Tail of male; lateral view.

The tail of the female is long (2.25–2.6 mm.), straight and tapering, and ends in a fine point. The caudal papillae are situated at about 1.6 mm. from the tip. The vulva opens at 7.75–10.3 mm. from the posterior end. The vagina is about 1.5 mm. long. The ova measure about 0.15 × 0.105 mm., have a shell 5 μ thick,

and contain an embryo curled upon itself into a U-shape when ready for laying.

The material from *Hardella thurgi* so closely resembles that from *Kachuga* in almost all respects that we do not feel justified in erecting another species for it. There are, however, certain differences, of which the most conspicuous are the greater relative and absolute width of the head and the much coarser striation of the cuticle. The striae in the *Hardella* material are about 10 μ apart, whereas in the *Kachuga* material they are so fine that accurate measurement is scarcely possible. Apart from these points the *Hardella* material is slightly larger in almost all dimensions than that from *Kachuga*, and has a stouter general appearance. The measurements may be most conveniently given in tabular form, for comparison with those of the *Kachuga* material:—

					♂	♀
					mm.	mm.
Length	..	..	..	..	18.6–20.4	20.2–22.1
Thickness (max.)	..	..	..	..	0.8–0.9	0.8–1.05
Diameter of head	..	..	..	..	0.28–0.3	0.3–0.35
Length of tail	..	..	..	..	1.8–1.9	2.5–2.7

		♂	♀
		mm.	mm.
Distance from ant. end to end of oesoph. (incl. bulb)	..	2.6-2.8	2.7-2.8
,, ,, nerve-ring	..	0.56	0.6
,, ,, excretory pore	..	1.9	2.0
Length of pharynx	..	0.1	0.1
Oesophageal bulb, length	..	0.55-0.58	0.6
,, ,, greatest diameter	..	0.35	0.4
Spicules, length	..	0.54-0.56	....
Vulva, distance from posterior end	..	....	8.5-8.8
Caudal papillae, ♀, distance from tip of tail	..	....	2.0
Ova, measurements	..	....	0.15 × 0.0875

Falcaustra kachugae, according to Stewart's (1914) description, seems to differ notably from *F. stewarti* in its much smaller dimensions; but as the type-material consisted only of a single female, which may not have been mature, the question of identity must be left open.

In view of the several new species just described, it is necessary to revise our conception of the generic diagnosis of *Falcaustra*. Diagnoses have been attempted by Seurat (1918) and by Baylis (1920 *b*), but both require some alteration. The following is an attempt at a fresh generic characterization.

Falcaustra, Lane, 1915.

Ascaroidea: Kathlanidae:¹ Meromyarian. Body usually stout, tapering at each end. Lateral fields wide. No lateral alae. Mouth with three lips, each bearing two outer and two inner papillae; the pulp of each outer papilla sends a branch to one of the inner papillae, and is thus Y-shaped. Buccal cavity short, surrounded by a continuous ring² of thickened cuticle. Muscular oesophagus divided into a short anterior portion, or pharynx, and a long posterior portion, the latter ending in a well-marked bulb which is constricted in the middle so as to take the form of two more or less distinct swellings connected by a narrower neck. The oesophagus, with the exception of the bulb, is usually considerably coloured with a reddish-brown pigment, and there are generally special masses of this pigment in the region of the nerve-ring. Excretory pore towards the posterior end of the oesophagus. Tail in both sexes tapering and pointed. Caudal end of male without alae, and provided with ten or more pairs of papillae (of which three pairs are constantly preanal), and an unpaired, median precloacal papilla. Of the postanal papillae two pairs are constantly lateral. Preanal caudal muscles well-developed, sometimes aggregated into one or several fan-shaped groups to form sucker-like organs. Spicules equal, sickle-shaped, broad dorso-ventrally and compressed laterally, each having the appearance of a spicule within a spicule. An accessory piece usually present, sometimes imperfectly chitinized or even absent. Vulva towards posterior third of body. Vagina runs forward and gives off two opposed uteri, each of which doubles upon itself in a number of longitudinally-disposed U-shaped loops in the anterior or posterior region of the body respectively. Each ovary forms a loop in the

¹ Travassos (1918) established this family to include the genera *Kathlania*, *Tonaudia*, *Falcaustra* and *Florenciaia*. It is the family Pseudo-heterakidae, Travassos, 1917, renamed and reconstituted. No family diagnosis, however, seems to have been attempted. In our opinion the genus *Cruzia*, Travassos, 1917, should also be included in the family, and not referred to a separate family Cruzidae, as Travassos has proposed. We have also to add a further new genus, closely allied to *Falcaustra* (see below, p. 310).

² Seurat (1918) in his diagnosis of the genus, speaks of the buccal cavity being "encadrée dans sa région moyenne par trois plaques chitineuses." If such a structure exists in *F. lambdiensis*, the form studied by him, it would appear to approach our genus *Zanclophorus* (see below, p. 310), though the rest of its characters seem to be those of *Falcaustra*.

anterior region of the body, that belonging to the anterior uterus being confined to this region, while the posterior ovary eventually runs back to terminate in the hinder region. Ova usually large and thick-shelled, of oval shape, and laid at different stages of development in different species.

Hab. Intestine of Chelonia and freshwater fishes.

Genotype : *F. falcata* (v. Linst., 1906), from *Geoemyda trijuga*.

Owing to the great similarity in structure between most of the species of *Falcaustra*, specific determination depends very largely upon measurements. The following admittedly artificial attempt at a key to the species is based almost entirely on male characters, and therefore omits one species (*F. kachugae*) of which only the female is known.

A. Inhabiting tortoises.

I. Several preanal sucker-like organs present in male.

- | | | |
|----|---|-----------------------|
| a. | Pairs of caudal papillae 10; spicules about 0.9 mm. | |
| | long | <i>siamensis</i> . |
| b. | Pairs of caudal papillae 11; spicules about 1.3 mm. | |
| | long | <i>lamaldiensis</i> . |

II. Preanal sucker-like organs absent.

- | | | | |
|----|--------------------------------|----|---------------------|
| a. | Pairs of caudal papillae 10 | .. | <i>falcata</i> . |
| b. | Pairs of caudal papillae 11 | .. | <i>testudinis</i> . |
| c. | Pairs of caudal papillae 16-18 | .. | <i>stewarti</i> . |

B. Inhabiting fishes.

- | | | |
|----|--|----------------|
| I. | A preanal sucker-like organ present in male. | Head wider |
| | than neck | <i>barbi</i> . |

- | | | |
|-----|-----------------------------------|-----------------------|
| II. | Preanal sucker-like organ absent. | Head narrower than |
| | neck | <i>leptocephala</i> . |

Genus *Zanclophorus*, nov.

The collection contains two interesting species which are clearly very closely related to *Falcaustra*, but differ from it, in our opinion, sufficiently to necessitate the formation of a new genus, which may be defined as follows:—

Kathlanidae: closely resembling *Falcaustra* in general appearance. Head somewhat narrower than neck, surrounded by a slight cuticular collar at the base. Three large, flattened lips, each carrying a pair of rather prominent papillae, and bordered internally by cuticular fringes. A long and wide buccal cavity present, with a cuticular lining. In place of the continuous cuticular ring which surrounds the buccal cavity in *Falcaustra*, there are three separate cuticular supports, in the form of double horse-shoes, at the corners of the mouth. There is no distinct pharynx, but the structure of the oesophagus is otherwise the same as in *Falcaustra*, and it is coloured in the same way with reddish pigment, of which there is a special mass in the neighbourhood of the nerve-ring. Bulb pear-shaped, with narrow middle region. Cervical papillae small and sessile, some distance behind the nerve-ring. Excretory pore towards hinder end of oesophagus. Caudal end of male without alae, but with a single, well-developed, muscular, preanal sucker (not a mere fan-like arrangement of muscles). Spicules similar to those of *Falcaustra*, but relatively much longer. A large, but not completely chitinized, accessory piece present. Female genital organs as in *Falcaustra*.

Hab. Stomach and intestine of Chelonia.

Genotype : *Z. annandalei*, sp. nov., from *Testudo travancorica*.

***Zanclophorus annandalei*, sp. nov.**

(Figs. 45-48.)

Host: *Testudo travancorica*. Position: stomach. Locality: Cochin State Forests, Western Ghats.

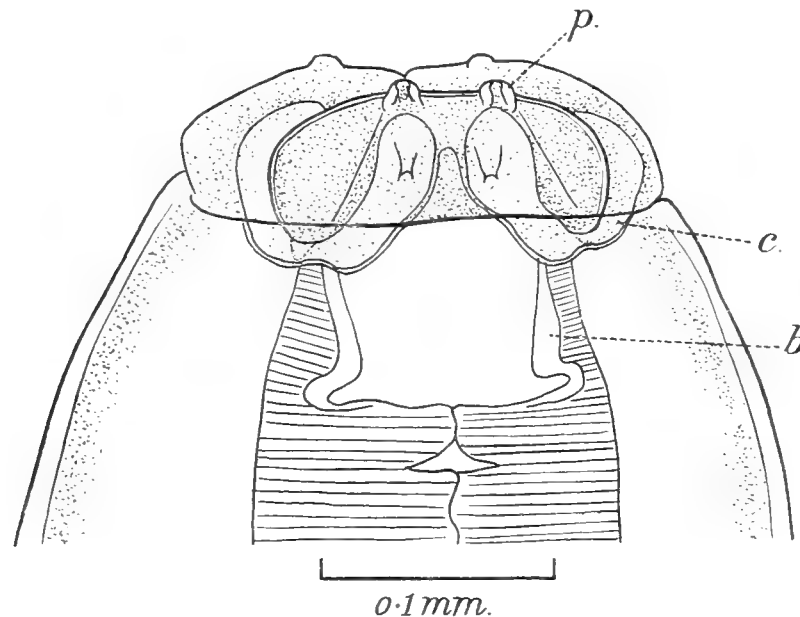


FIG. 45.—*Zanclophorus annandalei*. Head of female; dorsal view.

b., lining of buccal cavity; c., one of the three cuticular supports; p., papilla.

The male measures 15.5-15.9 mm. in length, the female 15.0-17.4 mm. The maximum thickness is 0.85-1.1 mm. The cuticular striations are about $2\ \mu$ apart. The head (figs. 45, 46) has a diameter of 0.2-0.23 mm. The buccal cavity measures 0.14-0.15 mm. in length and 0.09 mm. in greatest diameter. The distance from the anterior end to the end of the oesophagus, including the bulb, is 2.6-2.85 mm. The bulb measures 0.6-0.65 mm. in length and 0.4-0.44 mm. in diameter. The cervical papillae are at 1.5-1.74 mm., the nerve-ring at 0.55-0.6 mm., and the excretory pore at 2.2 mm., from the anterior end.

In the male, the tail (figs. 47, 48) is 0.45-0.5 mm. long. The sucker is situated at about 1.5 mm. in front of the cloaca. The caudal papillae are arranged in ten pairs and one median precloacal papilla. Of these, four pairs are postanal (2 ventral and 2 lateral), the rest preanal, consisting of three pairs close together near the

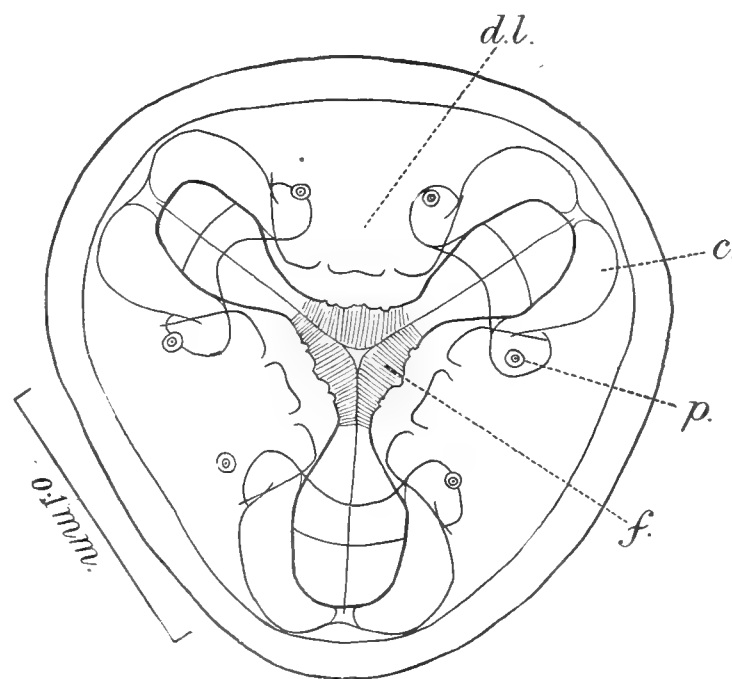


FIG. 46.—*Zanclophorus annandalei*. Lips, viewed en face.

c., one of the three cuticular supports; d.l., dorsal lip; f., cuticular fringe of lip; p., papilla.

cloaca, and three more pairs, more widely separated, between these and the sucker. The spicules measure 2.2–2.3 mm. in length, and have a maximum width of 0.058 mm. The large accessory piece (figs. 47, 48, *a.p.*), which is only partially chitinized, is deeply cleft in front.

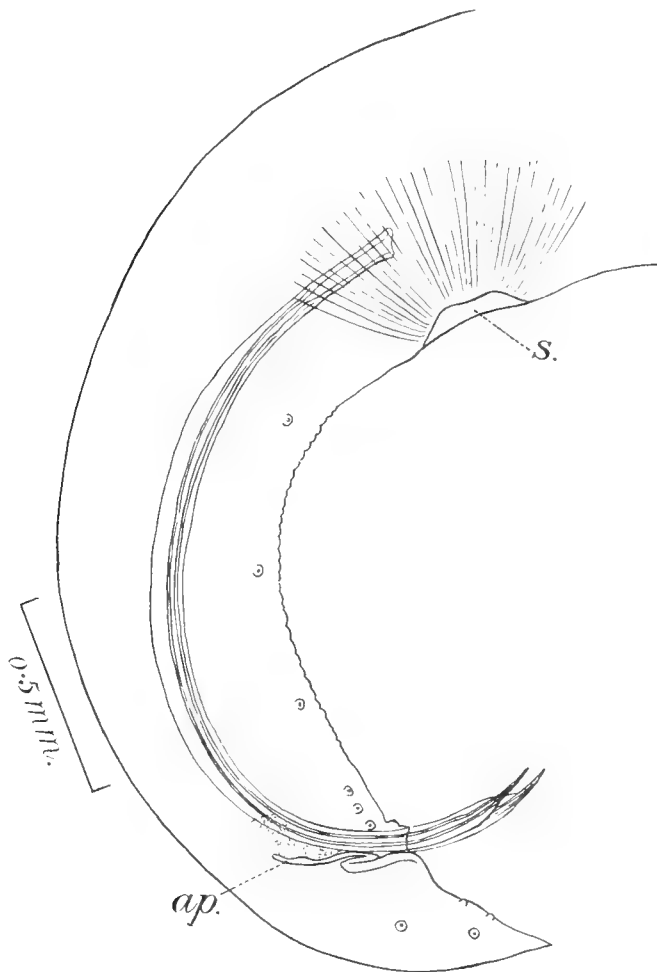


FIG. 47.—*Zanclophorus annandalei*. Posterior end of male; lateral view.

a.p., accessory piece: *s.*, sucker.

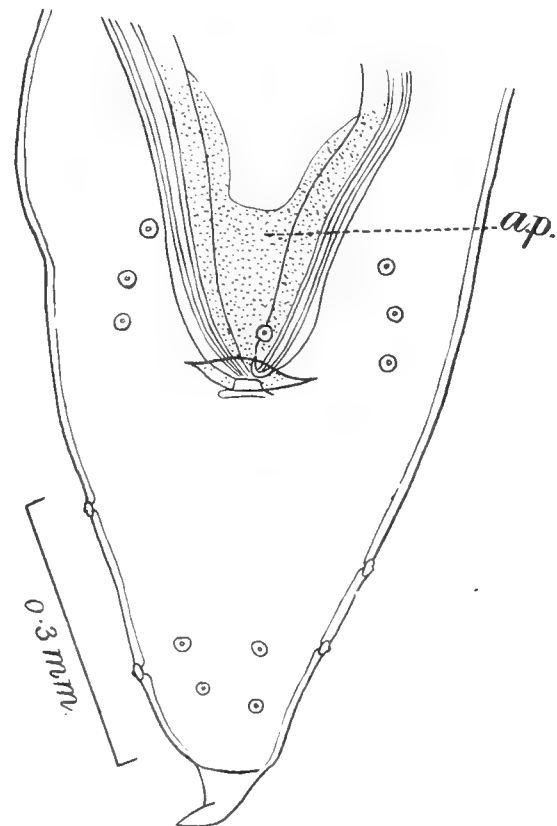


FIG. 48.—*Zanclophorus annandalei*. Tail of male; ventral view.

a.p., accessory piece.

In the female, the tail measures 0.7–0.75 mm. in length. The caudal papillae were not seen. The vulva opens at 5.0–5.5 mm. from the posterior end. The vagina runs forward for about 2 mm. before giving off the two directly opposed uteri. Very few of the females contained ova, and it may be doubted whether those seen were quite fully-formed. They measured about 0.125×0.075 mm.

Zanclophorus kempi, sp. nov.

(Fig. 49.)

Host: *Testudo elongata*. Position: intestine. Localities: Baradighi, Jalpaiguri, Bengal; and near Tura, foot of Garo Hills, Assam.

The length of the male is 10.9–12.8 mm., and its thickness 1.0–1.1 mm. The corresponding measurements for the female are 13.4–15.8 mm. and 1.2–1.4 mm. The cuticular striations are exceedingly fine. The diameter of the head is 0.22–0.24 mm. The buccal cavity measures 0.13 mm. in length and 0.09–0.1 mm. in greatest

diameter. The distance from the head end to the posterior end of the oesophageal bulb is 2.3–2.5 mm. The bulb measures 0.45–0.6 mm. in length and 0.4–0.48 mm. in diameter. The cervical papillae are at 1.5–1.6 mm., the nerve-ring at 0.52–0.58 mm., and the excretory pore at 1.7–1.95 mm., from the anterior end.

The tail of the male (fig. 49) is 0.45–0.55 mm. long. The sucker, which is deep and strongly muscular, is situated at about 1.1 mm. in front of the cloaca. There are nine pairs of caudal papillae and the usual median precloacal papilla. The arrangement is the same as in *Z. annandalei*, except that one of the three pairs immediately in front of the cloaca is absent. The two pairs present in this position are small, and the three more anterior pairs much larger. The spicules are relatively large, measuring 2.9 mm. in length and 0.1 mm. in width. The accessory piece is similar to that of *Z. annandalei*.

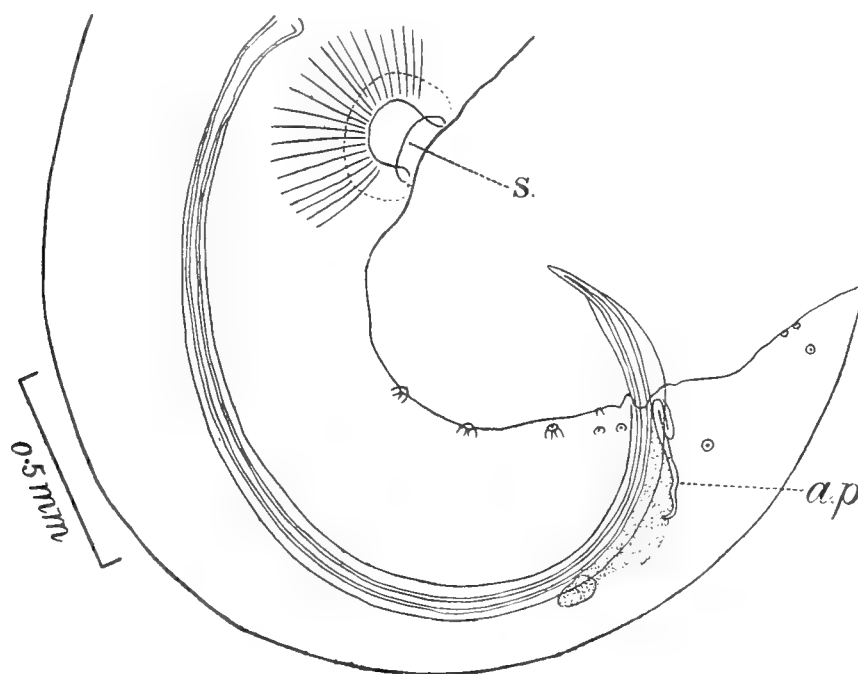


FIG. 49.—*Zanclophorus kempi*. Posterior end of male; lateral view.
a.p., accessory piece; s., sucker.

The tail of the female is bluntly conical, and measures 0.55–0.8 mm. in length. There is a pair of caudal papillae at 0.27 mm. from the tip. The vulva is situated at 4.0–4.8 mm. from the posterior end. The vagina is simple and narrow, about 2 mm. long, and runs forward as usual from the vulva. The eggs are oblong-oval in shape and measure 0.125–0.137 mm. \times 0.075–0.085 mm. The content is unsegmented.

It is always interesting to discover fresh cases of close relationship between the parasites of closely-related hosts, as showing how parallel evolution may be taking place in both hosts and parasites simultaneously. The present case is a very good example, neither the hosts nor their parasites having as yet developed sufficiently divergent characters to obscure their extremely close relationships.

Dr. Annandale has been good enough to supply us with the following interesting note on the hosts of our new genus:—

"*Testudo elongata* and *T. travancorica* belong to a small group of species which are very closely allied but remarkably isolated geographically. This group consists of four species: *T. travancorica*, from the southern part of the Malabar Zone of Peninsular India; *T. parallelus*, of which only a single specimen is known, from Chota Nagpur, in the middle of Peninsular India; *T. elongata*, with the widest range in the group, extending from Jalpaiguri in the extreme north-east of the plains of Bengal, through Assam, Burma and the northern part of the Malay Peninsula to Siam and Cambodia; and *T. forstenii*, from the island of Celebes. Discontinuous as the range of the group appears to be, the close structural similarity and the remarkable resemblance in facies indicate that the range was once continuous. Moreover, the existence of a single specimen from the interior of Peninsular India, captured many years ago, supports this view and suggests that rare annectant forms may linger on as yet undiscovered in inaccessible districts, perhaps of very limited area."

Superfamily **FILARIOIDEA**, Weinland, 1858.

Family **FILARIIDAE**, Claus, 1885.

Subfamily **FILARIINAE**, Stiles, 1907.

Genus "**Filaria**", *sens. lat.*

Filaria haje, Wedl, 1862 (?).

Young Filariid worms, perhaps belonging to this species, occurred twice in the intestine of the cobra (*Naja tripudians*) and twice in that of the banded krait (*Bungarus fasciatus*). All of these are immature forms, about 6–8 mm. in length, and without characters which would enable them to be assigned definitely to any well-established genus. They have a relatively long posterior glandular portion of the oesophagus. Wedl's (1862) description is very brief, and does not enable his species to be recognized with certainty. His specimens were found either free or encapsuled in the thoracic cavity, outside the lung. It is not indicated whether the present material occurred free in the lumen of the intestine or not.

Filaria abbreviata, Rud., 1819 (?).

(Fig. 50.)

The collection contains two female specimens of a Filariid from the orbit of *Saxicola*, sp. They are possibly referable to the above-named species, of which no full description appears to exist. Our material appears to agree fairly well with the account of *F. abbreviata* given by Molin (1858), and for this reason we tentatively refer it to this species.

The larger specimen is about 24 mm. long and 0.57 mm. in thickness. The anterior end of the body is abruptly attenuated and sharply truncated. The cuticle is smooth, and we are unable to detect the longitudinal rows of deciduous spines to which Molin refers. The mouth opens into a small buccal cavity which is about 0.032 mm. deep and 0.02 mm. in diameter. We are unable to distinguish any teeth at the base of the buccal cavity, but its wall is thrown into folds presenting an appearance which might easily have been mistaken for teeth. The oesophagus consists of two parts. The anterior portion is 0.25 mm. in length and distinctly more slender than the posterior portion. The latter measures 0.75 mm. in length and about 0.12

mm. in thickness. It is very slightly enlarged posteriorly. The nerve-ring surrounds the oesophagus at about 0.13 mm. from the anterior end, while the excretory pore opens at about 0.2 mm. from the head. The posterior extremity is rounded and not noticeably attenuated. The anus is small and subterminal. The vulva is situated close to the head, at about 0.45 mm. from the anterior end. There is a short transverse vagina, directed slightly backwards, from which two ovejectors are given off. The uteri and ovaries are both posterior, but a forwardly-directed loop in the ovejector of one of them indicates that this represents an anterior uterus. The eggs in the uterus measure about 0.024×0.017 mm., and are in various stages of segmentation.

Henry and O'Zoux (1909) include *F. abbreviata* in a list of species of the subgenus *Diplotrriaena*. Walter (1866) gives a description and figure of a worm from *Motacilla alba*, which he regarded as *F. abbreviata*, but these make it quite clear that his material belonged to a species of *Diplotrriaena*. He also describes and figures as a Filariid under the name of *F. (attenuata?)*, from *Corvus corone*, *Garrulus glandarius*, *Saxicola rubicola* and *Falco tinnunculus*, a form which is clearly a *Diplotrriaena*; and it seems not improbable that the material in both of these instances was referable to *D. tricuspis*, which is recorded from a very similar range of hosts. It appears to us questionable whether the original *F. abbreviata* was in reality a *Diplotrriaena*.

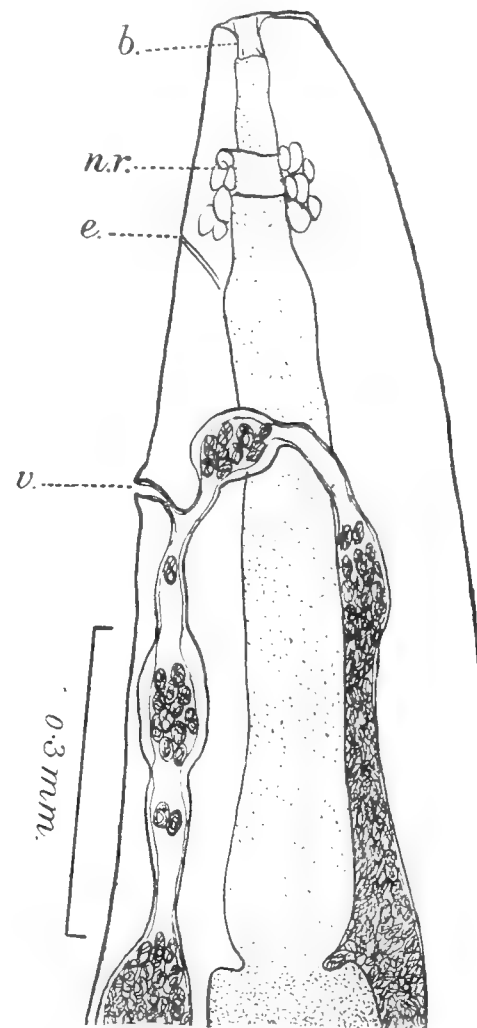


FIG. 50.—*Filaria abbreviata* (?). Anterior end of female; lateral view.

b., buccal cavity; e., excretory pore; n.r., nerve-ring; v., vulva.

"*Filaria*," sp.

A single specimen of a different species from those mentioned under *F. haje* occurred in the intestine of a cobra. It is an immature form measuring about 20 mm. in length. The anterior end is broad and blunt, the posterior end more tapering. The oesophagus is relatively shorter than in "*F. haje*."

Filaria macrophallos, Parona, 1889.

(Fig. 51.)

Hosts: *Varanus salvator*, *V. flavescens*, *V. nebulosus*, "Bengal monitor", *Varanus*, sp. Position: from the labels it is not quite clear whether the habitat is the actual cavities of the lungs, or the thoracic cavity. In three cases the lungs are mentioned, in one no position is specified, and in two the "intestines" are mentioned.

Great difficulty was evidently experienced in collecting whole specimens of this worm. We have only succeeded in finding one whole female among the material at our disposal, the rest consisting of much-tangled fragments.

The complete specimen came from an unnamed species of *Varanus*. It measures about 250 mm. in length and 1.4 mm. in thickness. The cuticle is marked throughout with prominent, raised, transverse wrinkles at irregular intervals, suggesting spines when seen in optical section. The head, which has a diameter about 0.45 mm., is squarish in front, the mouth often lying at the base of a funnel-like depression. There are two small, but prominent, chitinoid teeth, projecting forward, one on either side of the mouth. A little further back on each side there are three small, sessile, cephalic papillae. The oesophagus has a very short, narrow, anterior, muscular portion and a very long and wide, posterior, glandular portion. The length of the former is 0.6 mm.; of the latter, 30 mm. At its commencement the glandular portion occupies the whole width of the body-cavity. The nerve-ring surrounds the anterior portion somewhat behind its middle. Neither cervical papillae nor an excretory pore were seen.

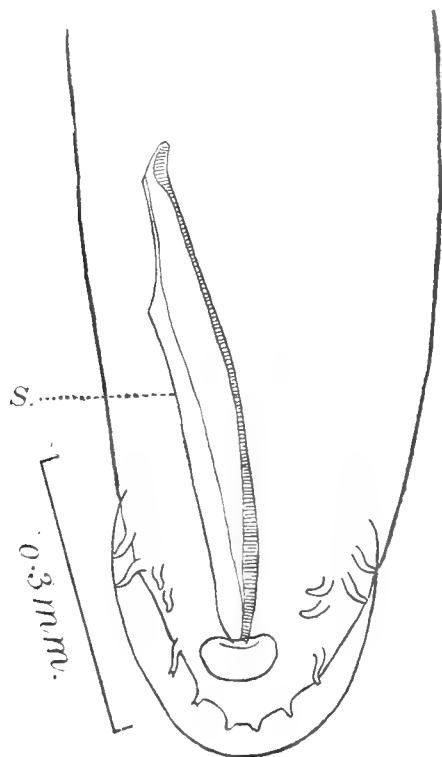


FIG. 52.—*Filaria varani*. Tail of male; ventral view.
s., spicule.

The anus is almost terminal. The tail-end is bluntly rounded, and carries a pair of papillae at its extremity. The vulva opens at 1.15 mm. from the anterior end. The muscular vagina may run straight back, or may be much convoluted. The ova (fig. 51) are of very characteristic shape, somewhat resembling a barrel, with an annular thickening near each pole. They measure 0.05×0.03 mm., have thick shells, and contain coiled embryos when ready for laying.

This species, according to Henry and O'Zoux (1909), should be referred to the genus *Diplotriana*, but with this view we are unable to agree.

Filaria varani, sp. nov.

(Fig. 52.)

A single male individual from *Varanus flavescens* does not agree with the male of *F. macrophallos*, and must be regarded provisionally as belonging to a new species. It measures about 108 mm. in length and 0.7 mm. in thickness. The characters of the anterior end are similar to those of *F. macrophallos*. The diameter of the head is 0.23 mm. The anterior portion of the oesophagus is 0.35 mm. in length, and the posterior portion 16 mm.

The tail (fig. 52) is 0.16 mm. long, and there are well-developed caudal alae, which are continuous round

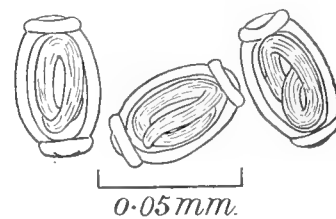


FIG. 51.—*Filaria macrophallos*. Ova.

the posterior extremity. Only one spicule¹ appears to be present, and this, from its position, seems to be that of the right side. It is a very broad structure, of characteristic shape (fig. 52, s.), and measures 0.6 mm. in length and 0.07 in width. There are seven pairs of caudal papillae, of which four are preanal. These and the most anterior postanal pair have long peduncles. Their arrangement is best indicated by means of the figure. The posterior lip of the cloacal aperture is tumid.

Genus **Setaria**, Viborg, 1795.

Setaria, sp. (?).

Three larvae, taken from "inner surface of cartilage" of a Javan mouse deer, or chevrotain (probably *Tragulus javanicus*).

The worms are of a Filariid type, but are too immature to show recognizable generic characters.

Subfamily *DIPLOTRIAENINAE*, Skrjabin, 1916.

Genus **Diplotriaena**, Railliet and Henry, in Henry and O'Zoux, 1909.

Diplotriaena tricuspis (Fedchenko, 1874).

The collection includes one male specimen belonging to this species, from Blandford's laughing-thrush (*Trochalopteron meridionale*).

Subfamily *MICROPLEURINAE*, nov.

Genus **Micropleura**, v. Linst., 1906.

Micropleura vivipara, v. Linst., 1906.

(Figs. 53, 54.)

Host: Gharial (*Gavialis gangeticus*). Position: Liver.

For the purpose of confirming the determination of this material, we were fortunate in being able to obtain from the Indian Museum five examples from the type series. These, as well as the new material, unfortunately proved to be all females, but we are in a position to add a few details to the description furnished by von Linstow (1906 a).

The dimensions of the female may be slightly larger than those given by that author, reaching about 43 mm. in length and 1 mm. in thickness. The cuticle, although without striations, is not perfectly smooth, as stated by von Linstow. There are distributed rather irregularly about its surface, especially on the hinder portion of the worm, little longitudinal series of from 2 to 7 very minute, raised, papilla-like structures. There is an appearance of a remarkable structure lining the body-cavity—i.e. within the musculature. This "structure" takes the form of a highly refringent network, strongly suggestive of a series of longitudinal tubules connected by smaller tubules running transversely. It seems probable, however, that this appearance is an artifact—it may perhaps be the result of the fluid contained in the

¹ In *F. macrophallos* there are two unequal spicules. Our specimen does not appear to be in any way damaged.

body-cavity having coagulated on fixation and formed a membrane which is thrown into folds in the peculiar pattern indicated.

The mouth is, as v. Linstow states, without lips. There are six small cephalic papillae, two lateral and four sublateral. The lateral papillae are slightly larger than the others. The diameter of the head at the level of the papillae is 0.15 mm. The

oesophagus is distinctly divided into an anterior, narrow, muscular portion and a much longer and wider, posterior, glandular portion. The muscular portion measures only 0.75–0.9 mm. in length, while the total length of the oesophagus is 3.25–3.5 mm. The muscular portion itself is slightly granular in appearance for nearly the posterior half of its length. It is surrounded by the nerve-ring at 0.67–0.8 mm. from the anterior end.

Contrary to the statement of v. Linstow, a minute excretory pore is present on the ventral surface a little behind the junction of the two portions of the oesophagus (at 1.0–1.1 mm. from the anterior end), and connected with this there is a structure apparently representing the excretory "bridge," into which faint indications of ducts can be seen coming from both anterior and posterior directions. These ducts, however, have not been traced along the lateral fields, nor has any connection been observed between them and the peculiar "network" already referred to.

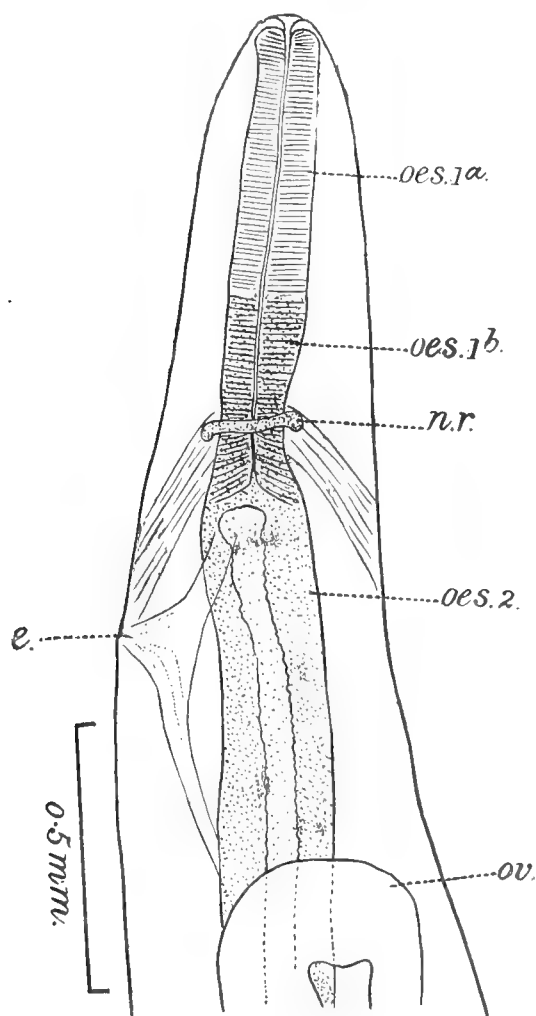


FIG. 53.—*Micropleura vivipara*. Anterior end of female; lateral view.

e., excretory pore; n.r., nerve ring oes.1^a., oes.1^b., two portions of anterior division of oesophagus; oes.2., posterior division of oesophagus; ov., oviduct.

The vulva is very hard to see in mature females, even when perfectly cleared, owing to the dense mass of embryos contained in the uterus. It is situated slightly in front of the middle of the body. The vagina consists of a very narrow, non-muscular duct running through the body-wall in a postero-dorsal direction from the opening, and a very short, somewhat muscular portion returning towards the head and connected with the uterus. The whole of the vagina is not more than 0.4 mm. in length. The two branches of the uterus are directly opposed, and form one continuous straight tube joining the ovaries, which are situated at opposite ends of the body-cavity. This tube fills the whole width of the body-cavity with the exception of the space occupied by the very narrow intestine, which runs in close contact with the body-wall. The ovaries are exceedingly short in proportion to the length of the worm. They are usually reflexed, but occasionally continued in a straight line with the uterus. They

are connected by narrow ducts with the respective ends of the latter. The development of the embryos appears to be very rapid, the uterus being entirely filled, from end to end, with young apparently fully-formed and not enclosed in membranes. These embryos have, as v. Linstow observes, a cuticle marked with conspicuous transverse striations, a blunt head and a long, tapering tail.

The tail of the adult female (fig. 54) is rounded at the tip, and measures 0.2–0.35 mm. in length. At 0.1–0.14 mm. from the tip, and somewhat towards the ventral side, there is a pair of large, prominent caudal papillae.

This genus, with the uteri directly opposed, the vulva placed far back from the head, the short ovaries, and the spicules of the male (according to v. Linstow) of equal length, does not appear to fit very well into any existing subfamily of Filariidae. It seems justifiable, therefore, to regard it as the type of a new subfamily, Micropleurinae.

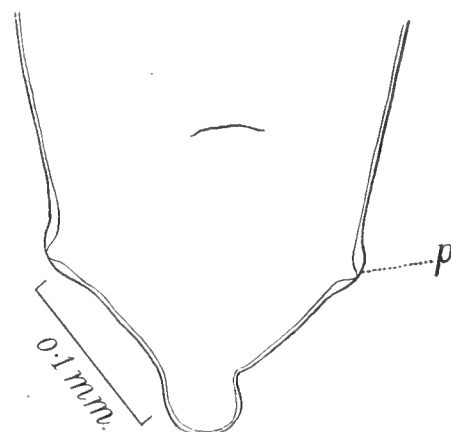


FIG. 54 — *Micropleura vivipara*. Tail of female; ventral view.
p., caudal papilla.

Superfamily **SPIRUROIDEA**, Railliet and Henry, 1915.

Family SPIRURIDAE, Örley, 1885.

Subfamily ACUARIINAE, Railliet, Henry and Sisoff, 1912.

Genus **Acuaria**, Bremser, 1811.

Acuaria (Acuaria) anthuris (Rud., 1819).

One female, which we assign to this species, was collected from the Red-billed Blue magpie (*Urocissa occipitalis*).

Acuaria (Echinuria) leptoptili (Gedoelst, 1916).

(Figs. 55, 56.)

This form was collected from the Adjutant (*Leptoptilus dubius*), at Calcutta. The species was described by Gedoelst (1916) from females only. The type host was *Leptoptilus crumenifer*.

The females in the present collection measure from 13 to 15 mm. in length, and about 0.36 mm. in thickness; the males 11 to 11.5 mm. and 0.234 mm. respectively. The cuticle has fine transverse striations about $4\ \mu$ apart. At the anterior end it is ornamented with "cordons." These cordons actually consist of a continuous band folded so that two folds lie dorsally and two ventrally. The transverse portions of the band are arranged so that they run across the lateral lines posteriorly and across the dorsal and ventral surfaces anteriorly. The cordons are 0.02 mm. broad and they extend backwards to a point about 1.1 mm. from the anterior end. The posterior transverse portions show a slight forward bend as they cross the lateral lines. The disposition of the longitudinal portions is not markedly asymmetrical or inclined to-

wards the ventral surface, as described by Seurat (1919), for *Echinuria*, Soloviev, 1912, and there are no cuticular spines. The cervical papillae are prominent and slender and are situated a little behind the lateral bends of the cordons.

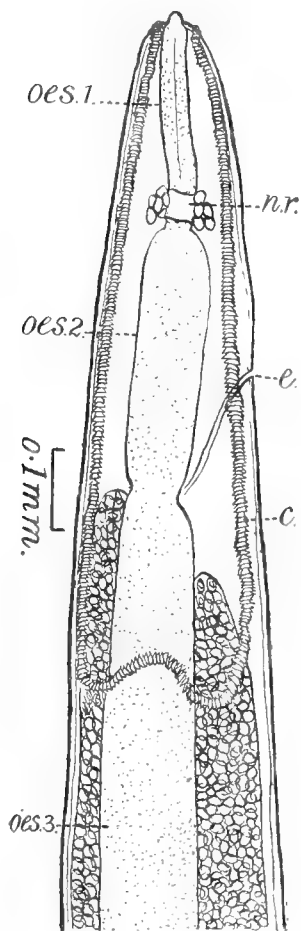


FIG. 55.—*Acuaria* (*Echinuria*) *leptoptili*. Anterior end of female; lateral view.

c., cordon; e., excretory pore; nr., nerve-ring oes.1., oes.2., oes.3., three divisions of oesophagus.

The head is small and provided with two simple lips, and is not constricted off from the body. The oesophagus consists of the usual three portions, a pharynx, a muscular portion, and a glandular portion. These measure 0.31, 0.41, and 2.3 mm. respectively. The nerve-ring surrounds the oesophagus at about 0.27 mm. from the anterior extremity, while the excretory pore opens at about 0.54 mm. from the head. The vulva opens at about 0.17 mm. from the tip of the tail. Its anterior lip is modified into a prominent bulla. From the vulva there is a long, straight, muscular-walled vagina which runs forward for about 1.4 mm. and then turns transversely to join the uterus. The species may be considered to be monodelphic, the posterior set of organs being represented merely by a blind sac-like uterus which runs back to the vicinity of the vulva. The anterior uterus runs forward to within 1.75 mm. of the anterior end of the body, the ovary commencing at this point and running backwards. In a mature specimen practically the whole of the body-cavity is occupied by the uterus, which is packed with eggs containing fully-developed embryos. The ova measure 0.028×0.018 mm. The anus is situated at 0.05 mm. from the tip of the tail.

The tail of the male forms several turns of a spiral. Membranous alae are present, extending for about 0.7 mm. from the tip of the tail. The cloaca opens at 0.115 mm.

from the tip of the tail. There are nine pairs of supporting papillae in the alae; 4 preanal pairs, about equidistant from each other and close to the cloaca, and 5 postanal. The postanal papillae are arranged as follows: four pairs in a group, occupying the posterior half of the tail, and one pair about midway between this group and the anus. The papillae are all stalked and slender, the preanal ones being much longer than the postanal. The spicules are unequal and dissimilar. The right spicule is long and slender. It is gently curved, and if partly extruded the distal portion may be generously incurved but it is not twisted. It measures 0.65–0.675 mm. The left spicule (fig. 56), is short and very much curved. It lies roughly at right angles to the long axis of the right spicule, measures 0.19–0.21 mm. in length, and is twisted and flanged. The root of the spicule is expanded. Its edges are faintly serrated in the part towards the tip. The testicular coil runs forward to within 3.5 mm. from the head.

A genus *Echinuria* (genotype *E. jugadornata*) was erected by Soloviev in 1912, the month of publi-

cation being September. In December of the same year Railliet, Henry and Sisoff published a note on the relationships of the members of the genus *Acuaria*, Bremser, 1811, and erected a new sub-family Acuariinae containing the genera *Acuaria* (type), Bremser, 1811, *Cosmocephalus*, Mol., 1858, *Histiocephalus*, Dies., 1851, and *Streptocara*, Raill., Hen. and Sis., 1912. The members of the genus *Acuaria* were separated as far as possible into five sub-genera, viz., *Acuaria*, *Cheilospirura*, Diesing, 1860, *Dispharynx*, Raill., Hen. and Sis., 1912, *Synhimantus*, Raill., Hen. and Sis., 1912, and *Hamannia*, Raill., Hen. and Sis., 1912.

The sub-genus *Hamannia* is recognised by Seurat (1919) as a synonym of *Echinuria*, Soloviev, 1912. While he retains full generic rank for the latter, for his new genus of 1918, *Chevreuxia*, and for *Rusguniella*, a genus erected in the same paper, he assigns species to the following sub-genera of *Acuaria*: *Acuaria*, *Dispharynx* and *Synhimantus*.

The emended diagnosis of the genus *Acuaria*, Bremser, 1811, given by Railliet, Henry and Sisoff, runs as follows: Acuariinae without vesicular swelling at the anterior end, but bearing four cutaneous cordons in the form of gutters or bands salient from or countersunk in the cuticle, these cordons extending sometimes directly backwards, more often returning forwards or even united two by two across the lateral surfaces. Parasites of the oesophagus, ventriculus, or gizzard. Type, *Acuaria anthuris* (Rud., 1819).

Accepting this definition, then, we can see no reason why *Echinuria*, Soloviev, 1912, *Rusguniella*, Seurat, 1919, or *Seuratia*, Skrjabin, 1916, should be given full generic rank.

The suggested arrangement, then, is as follows: ACUARIINAE, Raill., Hen. and Sis., 1912: Genotype, *Acuaria*, Bremser, 1811. Other genera: *Cosmocephalus*, Mol., 1858; *Histiocephalus*, Dies., 1851; *Streptocara*, Raill., Hen. and Sis., 1912; *Chevreuxia*, Seurat, 1918.

Genus *Acuaria*, Bremser, 1811. Sub-genera: *Acuaria*, Bremser, 1811, *emend.* Raill., Hen. and Sis., 1912; *Cheilospirura*, Dies., 1860, *emend.* Raill., Hen. and Sis., 1912; *Dispharynx*, Raill., Hen. and Sis., 1912; *Synhimantus*, Raill., Hen. and Sis., 1912; *Echinuria*, Soloviev, 1912; *Rusguniella*, Seurat, 1919; *Seuratia*, Skrjabin, 1916.

Sub-genus *Echinuria*, Soloviev, 1912 (Synonym *Hamannia*, Raill., Hen. and Sis., 1912). Diagnosis after Raill., Hen., and Sis. (1912):—*Acuaria* with cuticular cordons non-recurrent but anastomosed in pairs across the lateral lines. Body sometimes spiny. Males with spicules unequal and unlike. Four or five pairs of postanal papillae.

Habitat: ventriculus or gizzard.

Type, *Acuaria (Echinuria) jugadornata*, Soloviev, 1912.

Other species: *A. uncinata* (Rud., 1819); *A. contorta* (Molin, 1858); *A. longeornata* (Mol., 1860); *A. calcarata* (Mol., 1860); *A. spinifera* (Schneider, 1866); *A. squamata* (v. Linst., 1883); *A. phoenicopteri* (Seurat, 1916), *A. leptoptili*, Geddoelst, 1916.

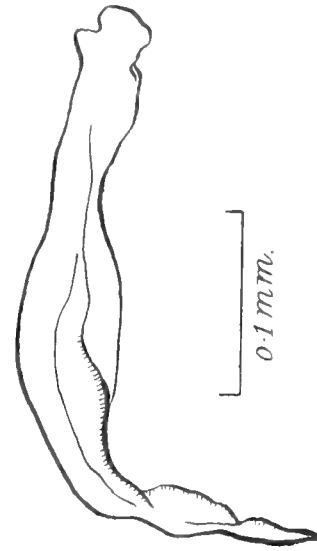


FIG. 56.—*Acuaria (Echinuria) leptoptili*. Left spicule; lateral view.

Subfamily *PHYSALOPTERINAE*, Stossich, 1898 (*fide* Stiles and Hassall).

Genus **Physaloptera**, Rud., 1819.

Physaloptera alata, Rud., 1819.

One immature female specimen was collected from Montagu's harrier (*Circus cineraceus*).

Physaloptera praeputialis, v. Linst., 1889.Syn. *Chlamydonema felineum*, Hegt, 1910.

Specimens of this curious form occurred in the following hosts:—

Fishing cat (*Felis viverrina*).Jungle cat (*Felis chaus*).Leopard cat (*Felis bengalensis*).Leopard (*Felis pardus*).

We are of the opinion that the form described by Hegt (1910) and discussed by Nierstrasz (1910) is identical with von Linstow's species, and that there is no justification for the erection of a separate genus *Chlamydonema*. The species has all the characters of a true *Physaloptera*, though complicated or obscured to a varying extent by the development of a cuticular caudal sheath.

Physaloptera, sp.Host: Indian fox (*Vulpes bengalensis*). Position: stomach.

Apparently the only species of *Physaloptera* recorded in foxes is *P. cesticillata*, Sonsino, 1889, from the Fennec fox (*Megalotis zerda*) of Northern Africa. The present material consists only of a single female specimen, and, in the absence of a male, it is impossible to identify it with Sonsino's species. In the characters of the lips, and in some other respects, our specimen appears to approach very closely to *P. digitata*, Schneider, 1866. This species, however, has only been recorded from the puma (*Felis concolor*) in Brazil, and without examining further material it would be unwise to suggest the identity of this with a form from the Indian fox.

Physaloptera, sp.

A number of immature forms, measuring about 5–7 mm. in length, were found in the intestine of a "Raket Bausi" (*Coluber*, sp.). In the apparent absence of the inner teeth of the lips they resemble *P. colubri* (Rud., 1819), according to von Drasche's (1883) account of that form; but since there are no sexually mature specimens the determination remains uncertain.

Family CAMALLANIDAE, Railliet and Henry, 1915.

Genus **Camallanus**, Railliet and Henry, 1915.**Camallanus kachugae**, sp. nov.

(Figs. 57–59.)

Host: *Kachuga smithii*. Locality: Ferozpore, Punjab.

This species has the typical characters of the genus, which appear to vary little except in small details in different species. The worms, as indicated by the collector's label, had the usual reddish colour during life. The total length is 10.9–14.5 mm. in the male and 20.8–22.0 mm. in the female. The male has a maximum thickness of 0.3–0.37 mm., the female of 0.45–0.5 mm. The cuticular striations are fine, the interval not exceeding 5 μ . The dorso-ventral diameter of the head, measured at the

anterior angles, is 0.13–0.15 mm. in the male, 0.17 mm. in the female. The chitinous buccal valves are slightly broader than long, their length (not including the posterior ring) being 0.11–0.13 mm. and their width about 0.14–0.16 mm. The number of longitudinal ridges on each valve is either eight or ten, the latter number being seen only in large specimens. The posterior ring of the buccal apparatus has a diameter of 0.1 mm. The dorsal and ventral “tridents” are well developed, and the middle prong measures 0.08–0.1 mm. in length. The head bears three papillae on each side near the extremity. The oesophagus shows the usual division into an anterior, clear, muscular portion and a posterior, more opaque, glandular portion. The former is distinctly club-shaped, and (measuring from the extremity of the head) 0.54–0.66 mm. in length. The total length of the two portions (from the head-end) is 1.18–1.55 mm. The minute, bristle-like cervical papillae are situated at 0.5–0.55 mm., the nerve-ring at 0.2–0.23 mm., and the excretory pore at about 0.5 mm., from the anterior end. The intestine is very narrow, considerably more so than the oesophagus.

In the male the tail measures about 0.21 mm. in length. The alar region is somewhat thicker than the preceding portion of the body. The ventral region between the alae is probably capable of being depressed by the action of the well-developed caudal muscles, so as to produce the effect of a sucker. The number and general arrangement of the caudal papillae are the same as those described for certain other species (*C. microcephalus*, *C. americanus*). Unfortunately, although a number of species of *Camallanus* have been described, the majority of the descriptions are very incomplete, and it is impossible to determine whether the number of papillae is constant throughout the genus. It seems probable, however, that the seven pairs of rib-like preanal papillae, projecting into the alae, will be found to be constant. The present species has, in addition to these (fig. 58), six pairs of postanal papillae and two small pairs of adanal papillae, as in the two other species cited. Their arrangement agrees more closely with that of *C. microcephalus* than that of *C. americanus*, in that the first, or most posterior, pair occupies an isolated position close to the tip of the tail. The second pair is also isolated. Pairs 3 to 5 form a group, close together. All these are lateral in position, while the sixth pair is more ventrally situated, just behind the cloaca. The two small adanal pairs are not indicated in the figure. The two spicules are very

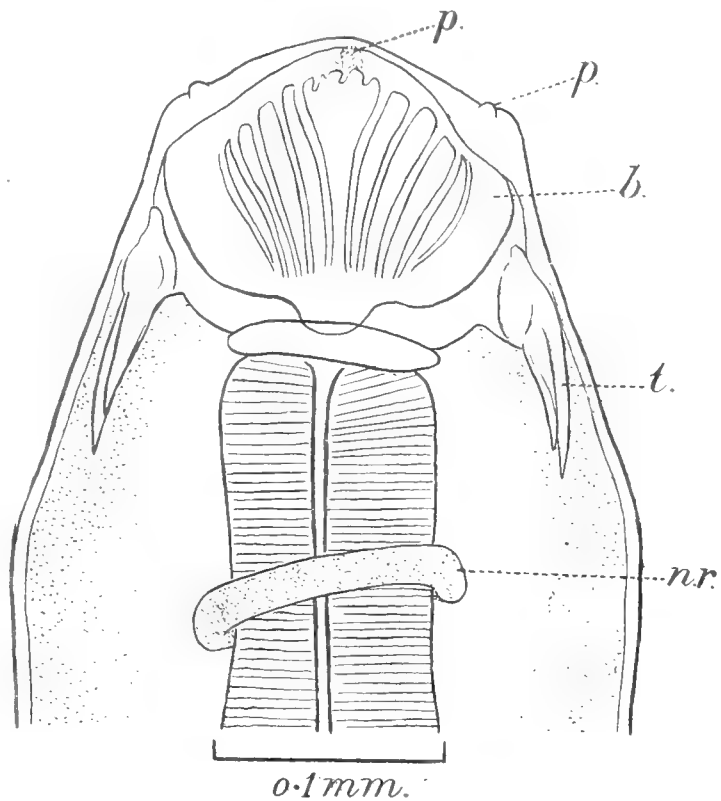


FIG. 57.—*Camallanus kachugae*. Head of female; lateral view.

b., buccal valve; n.r., nerve-ring; p., p., papillae; t., “trident.”

unequal. The right spicule is fairly stout and measures about 0.97 mm. in length. It has no barb or prong, such as is found near the tip in several species, but the tip appears to be simple and finely pointed. The left spicule is very slender and delicate, and measures only about 0.43 mm. in length.

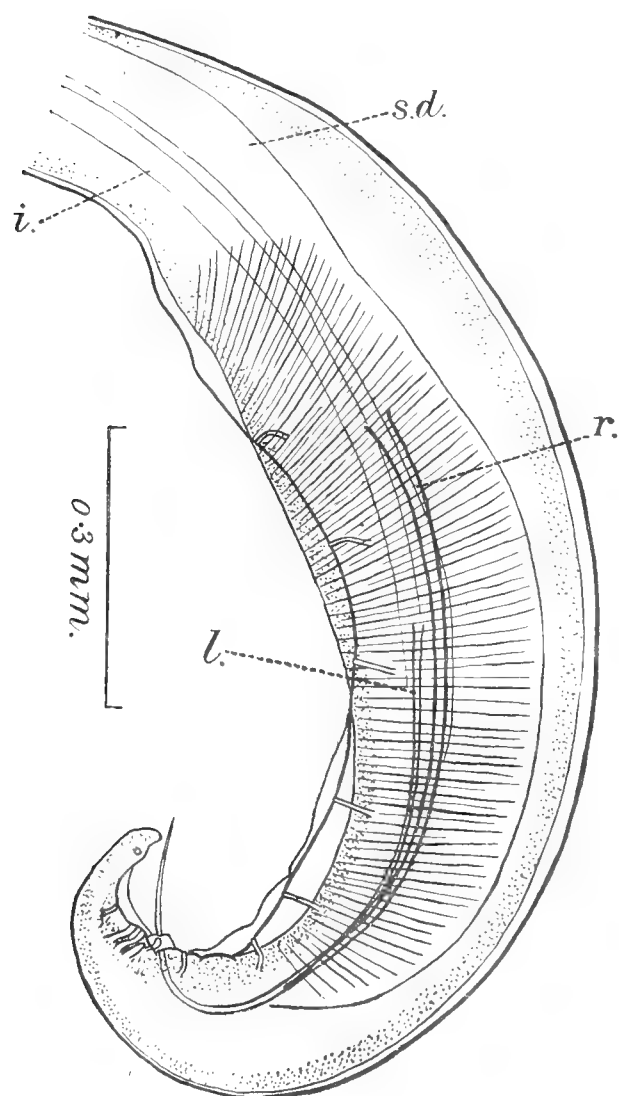


FIG. 58.—*Camallanus kachugae*. Posterior end of male; lateral view.

i., intestine; *l.*, left spicule; *r.*, right spicule; *s.d.*, sperm-duct.

The worm is, as usual, viviparous.

This form is extremely closely related to the European *C. microcephalus* (Duf., 1845). On comparison, however, with specimens which we believe to belong to that species, we find that, apart from size, which is too variable to be of much importance, *C. kachugae* differs from them in the following points:—

(1) The “tridents” of the buccal apparatus are of slightly different shape, their outer prongs being longer and more flattened and expanded at the free end in *C. microcephalus* than in *C. kachugae*. The colour of the whole buccal apparatus, and especially of the ring and tridents, is much darker in *C. microcephalus*.

(2) The longer (right) spicule of the male is simple in *C. kachugae*, pronged in *C. microcephalus*. In the former it measures 0.97 mm. in length, in the latter 0.85 mm.

(3) The lips of the vulva in *C. kachugae* are much more strongly developed than in *C. microcephalus*. In the latter the posterior lip is often completely hidden by the anterior lip.

As regards other species already described from tortoises, *C. americanus*, Magath, 1919, has a barbed

In the female the tail is about 0.3 mm. long, finger-shaped, rather blunt, and slightly bifid at the tip. There is a pair of caudal papillae at 0.17 mm. from the tip, situated in little dimples in the cuticle. The vulva is in front of the middle of the body, at 9.1–10.4 mm. from the anterior end. It has exceedingly prominent lips, the anterior lip being considerably larger than the posterior, and overlapping it. Each of the lips (fig. 59) consists of a cuticular swelling with granular contents, and has the appearance of being divided internally into a number of compartments by partitions originating from the cuticle. The muscular vagina is very narrow, running back almost in a straight line for about 2 mm. At its inner end it gradually widens into the short unpaired portion of the uterus, which continues to run posteriorly. The two uterine branches are directly opposed. The posterior branch, as usual, has no ovary, but ends blindly at a short distance in front of the anus. This blind

or pronged right spicule in the male. *C. dumerilii* (Perrier, 1871), as also the *C. dumerilii*, Perrier of v. Linstow, 1897 and 1909, and consequently the *C. confusus* of Railliet and Henry (1915), are probably all synonymous with *C. microcephalus*. *C. trispinosus* (Leidy, 1851) and *C. undulatus*, Railliet and Henry, 1915 (= *Cucullanus viviparus*, v. Linst., 1906, renamed), are so briefly described that it is doubtful whether the species can be identified. *C. roseus* (Leidy, 1851) probably belongs to another genus.

Magath (1919) is of the opinion that the *C. microcephalus* of Seurat (1915), from *Clemmys leprosa*, is a different species from *C. microcephalus* (Duj.), and proposes for it a new name, *C. seurati*. He considers it questionable whether any form can be identified from Dujardin's description, and yet appears to find in the two descriptions sufficient grounds for concluding that the species are distinct. Such discrepancies as there are in these descriptions, however, are in matters of measurement, and it is clear that these are subject to great variation. We feel, therefore, that Magath's view is somewhat premature, and regard Seurat's determination as

correct, unless a detailed comparison with material from *Emys orbicularis* should prove the contrary.

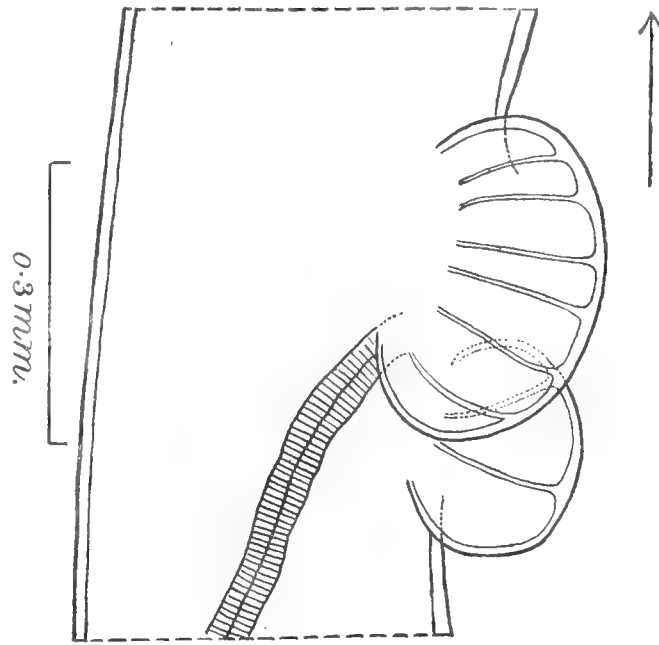


FIG. 59.—*Camallanus kachugae*. Vulvar region of female; lateral view.

The arrow points in the direction of the head. Intestine and uterus omitted.

Genus *Camallanides*, nov.

Camallanides prashadi, sp. nov.

(Figs. 60–63.)

Host: Banded krait (*Bungarus fasciatus*).

The buccal apparatus in this species differs somewhat from that typical for the genus *Camallanus*. The paired valves, on superficial examination, appear to be represented by four separate masses of brown chitin. Actually, these are joined together in lateral pairs by relatively thin plates on their inner surfaces, so that they are really pronounced external thickenings of the usual buccal valves. The usual rib-like structures, terminating in tooth-like projections anteriorly, are present on each inner plate to the number of about 14. The "tridents" are represented by simple chitinoid rods of rather irregular shape and of a yellow colour. These are connected at their bases with a dorsal and a ventral chitinoid body, lying opposite to the edges of the buccal valves.

The male measures 5.8–6.6 mm. in length and 0.21–0.25 mm. in thickness. The female is more than twice as large (14.2–17.7 mm. long and 0.4–0.47 mm. in maximum thickness). The cuticular striations are very fine and indistinct, at intervals of about 3–4 μ . The diameter of the head, measured dorso-ventrally at the anterior corners, is 0.08–0.09 mm. in the male, 0.12–0.13 mm. in the female. There appear to be three pairs of cephalic papillae. The measurements of the buccal valves are: length,

0.06 mm. in male, 0.09–0.1 mm. in female; width (dorso-ventral), 0.075 mm. in male, 0.1 mm. in female. The length of the rods representing the tridents is about 0.06 mm.

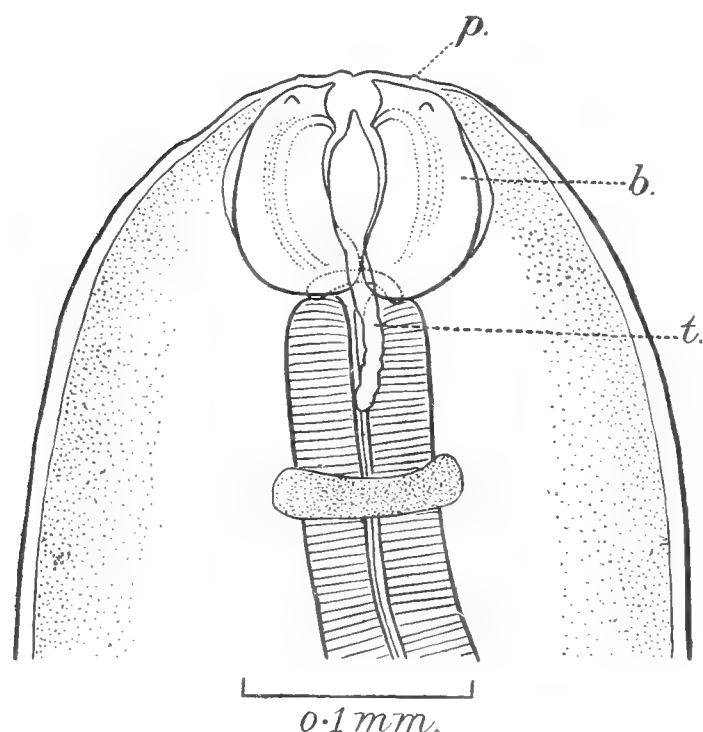


FIG. 60.—*Camallanides prashadi*. Head of female; dorsal view.

b., buccal valve; p., papilla; t., "trident."

the general structure characteristic of *Camallanus*, with well-developed alae and caudal muscles. The tail is very short (a little over 0.06 mm.), sharply pointed, and usually curled ventrally, with its tip hidden by the alae. The caudal papillae are elongate and rib-like, diminishing in size towards the tip of the tail. As in *Camallanus*, there are seven pairs of preanal papillae, projecting into the alae. There are two large pairs curving inwards towards the ventral surface at the sides of the cloaca, and five more pairs of lateral postanal papillae. The three anterior pairs of these are relatively large and close together. The spicules are markedly unequal in size and character. The right spicule is stout and provided with alae for the greater part of its length. It is about 0.24 mm. long. Its tip is curled into a hook, but there is no barb. The left spicule is without alae, slender and

in the male, 0.07–0.1 mm. in the female. The posterior ring of the buccal apparatus has a diameter of 0.033 mm. in the male and 0.045 mm. in the female. The oesophagus has the same structure as in *Camallanus*, the anterior muscular portion measuring (from the extremity of the head) 0.38 mm. in length in the male, 0.47–0.5 mm. in the female. The distance from the head-end to the posterior end of the glandular portion is 0.8 mm. in the male, 1.02–1.08 mm. in the female. The nerve-ring is situated at 0.15 mm. in the male, 0.19 mm. in the female, from the anterior end; the excretory pore at 0.25 mm. (male), 0.31 mm. (female); and the minute, bristle-like, cervical papillae at 0.28 mm. (male), 0.35 mm. (female).

In the male, the caudal region has

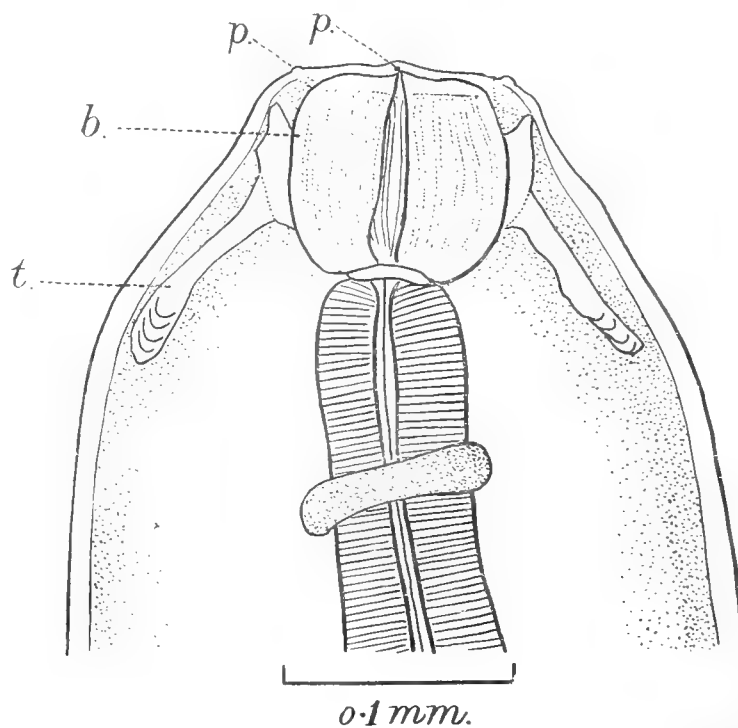


FIG. 61 —*Camallanides prashadi*. Head of female; lateral view.

Lettering as in fig. 60.

tapering, and measures only about 0.14 mm. in length. There is a yellow chitinous accessory piece, more or less triangular in shape and measuring about 0.025 mm. in length.

In the female the tail is relatively long (0.4–0.6 mm.), and gradually tapering, with the exception of a slight thickening just before the conical tip. No caudal papillae were seen. The general arrangement of the genital organs is that seen in *Camallanus*, but the prominent lips of the vulva are here modified into a tubular appendage (fig. 63,) somewhat flattened dorso-ventrally and projecting freely from the body-wall in a posterior direction to a distance of 0.3–0.4 mm. This appendage originates at a point a little behind the anterior third of the length of the worm (at 5.9–6.1 mm. from the head-end). The vulvar aperture is situated on the ventral surface of this structure, near its extremity. The muscular vagina runs from the opening to the base of the appendage, and then turns back just within the ventral body-wall, running

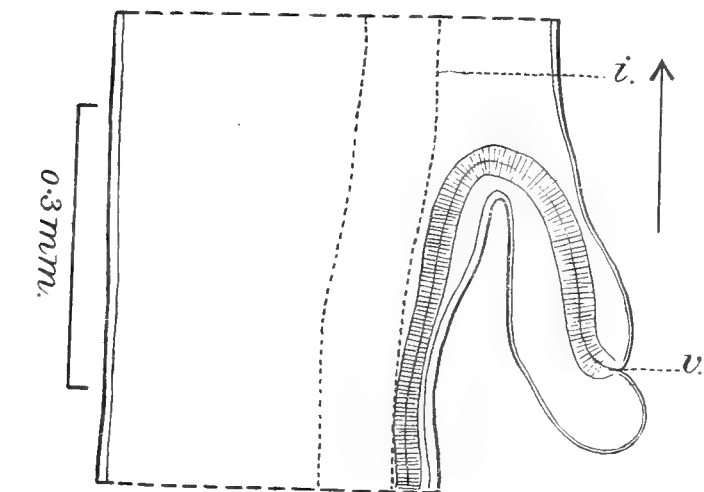


FIG. 63.—*Camallanides prashadi*. Vulvar region of female; lateral view.

i., intestine; v., vulva. Uterus, full of embryos, omitted. The arrow points in the direction of the head.

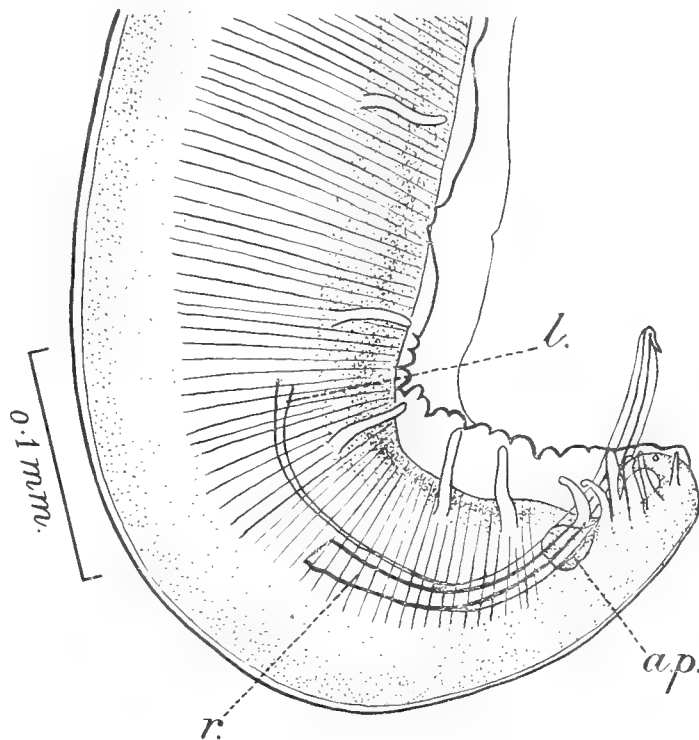


FIG. 62.—*Camallanides prashadi*. Posterior end of male; lateral view.

a.p., accessory piece; l., left spicule; r., right spicule.

straight back for about 2 mm. before opening into the uterus. The posterior branch of the uterus is, as in *Camallanus*, without an ovary. The worm is viviparous, both branches of the uterus, in mature females, being filled from end to end with free embryos.

We have considered it necessary to make this form the type of a new genus, on account of the following important characters in which it differs from *Camallanus*:—

- (1) The structure of the chitinous buccal valves, each of which has two large thickenings, giving the appearance of two separate masses of chitin.
- (2) The reduction of the “tridents” to simple, rod-like structures.

(3) The alate condition of the right spicule, and the presence of an accessory piece, in the male.

(4) The presence of a tubular appendage, carrying the vulva, in the female.

A nematode has been described under the name *Camallanus bungari* from *Bungarus candidus*, in Java, by MacCallum (1918). The description of this form is not easy to understand, but it appears impossible to identify it with the species just described, the most striking difference being that, whereas in the present form the vulva is situated on a very conspicuous outgrowth from the body-wall, in *C. bungari* it appears to have had no prominent lips, and to have been so inconspicuous that some doubt remained as to its position. At the same time it may be observed that the accompanying figure in MacCallum's paper (*l.c.*, fig. 65) gives quite a different impression from the description, and shows an arrangement of the uterus and vagina hitherto unknown in the genus *Camallanus*.

Family GNATHOSTOMIDAE, Railliet, 1895, *emend.* Baylis and Lane, 1920.

Subfamily SPIROXYINAE, Baylis and Lane, 1920.

Genus *Spiroxys*, Schneider, 1866.

Spiroxys annulata, sp. nov.

(Figs. 64, 65.)

Host: *Chitra indica*. Position: stomach. Locality: Budha Stream, Ludhiana, Punjab.

This species, which was collected by Dr. Bains Prashad, approaches closely to the only other Indian species of *Spiroxys* at present known (*S. gangetica*, Baylis and Lane, 1920). In size, and also in the dimensions of many of its organs, it is intermediate between that species and the genotype, *S. contorta* (Rud.).

The lips, when seen in a lateral view, have a very similar shape to those of *S. gangetica*, the dorsal and ventral lobes being placed almost at right angles to the middle lobe. In a dorsal or ventral view, however, the thickness of the lips is relatively much less than in *S. gangetica*, and they are seen to be much more wedge-shaped (fig. 64), so that the head has not the same square appearance in such a view. The six pointed teeth on each lip (two on each lobe), characteristic of *S. gangetica*, are absent in the present species. The cuticular thickening on the inner surface of the middle lobe is well developed, but does not form a distinct tooth at its apex.

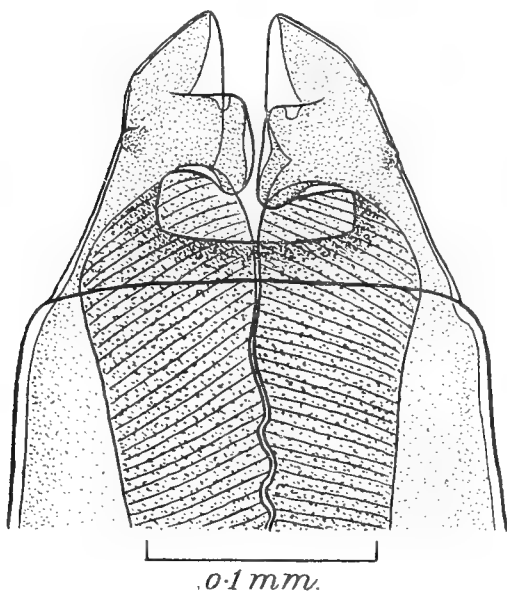


FIG. 64.—*Spiroxys annulata*. Head of female; dorsal view.

The total length is from 20 to 25.4 mm. in the male, and 30 to 34 mm. in the female.

The maximum thickness is 0.5–0.6 mm. in the male, 0.8–0.85 mm. in the female. The diameter of the lips, measured dorso-ventrally, is 0.16 mm., and their length 0.06 mm. The transverse striations of the cuticle are exceptionally coarse (up to

0.025 mm. apart), forming a series of rings with prominent posterior edges, so that in optical section the outline of the body has a rather saw-like appearance.

There is a well-marked cuticular collar (seen also in *S. gangetica*) just behind the base of the lips (fig. 65, c).

The tail is unusually short (about 0.2 mm.) in both sexes. The length of the oesophagus (measured from the anterior extremity of the lips) is 2.8–3.5 mm. Except for a short portion at the anterior end, which is purely muscular, its walls contain many pocket-like glands arranged in several linear series. The cervical papillae, which are prominent and resemble small, backwardly-directed spines, are situated at a little over 1 mm. from the anterior end. The nerve-ring is at 0.62–0.65 mm., and the excretory pore at 0.8 mm., from the anterior end.

The inflation of the caudal alae in the male is very pronounced. As usual in the genus, they are joined anteriorly by an inflated cushion of cuticle which passes over the ventral surface in front of the cloaca. There is also a sucker-like preanal depression, produced by the well-developed caudal muscles, within the bursa-like area thus marked out. There is nothing worthy of special notice in the caudal papillae, which are present to the usual number (11 pairs) and arranged as in the other members of the genus. The lateral papillae are, as usual deeply buried in the inflated alae. The small pre- and postcloacal pairs are sessile. The spicules are nearly equal in length (from 1.6 to 2.3 mm.), slender, cylindrical and finely pointed.

The tail of the female is sharply conical, with the tip bent ventrally. The caudal papillae are at 0.17 mm. from the tip. The vulva is situated slightly behind the middle of the body, at 13.8–15.5 mm. from the posterior extremity. The muscular vagina is very narrow, running forward from the vulva. The ova have a very thin, membranous shell, measuring about 0.075 × 0.06 mm.

Subfamily *GNATHOSTOMINAE*, Baylis and Lane, 1920.

Genus *Tanqua*, R. Blanchard, 1904.

Tanqua tiara (v. Linst., 1879).

This common form occurred in great abundance in monitors of the following species:—

Varanus salvator,
V. flavescens,
V. nebulosus,
V. bengalensis.

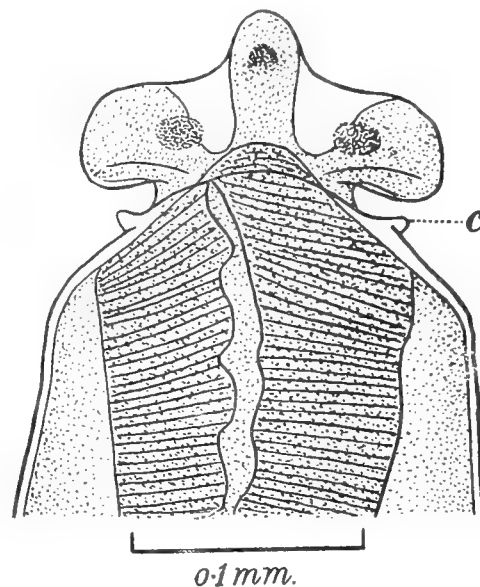


FIG. 65.—*Spiroxys annulata*. Head of female; lateral view.
 c., cuticular collar.

Tanqua anomala (v. Linst., 1904).

Hosts :

“Mud snake,”

Banded krait (*Bungarus fasciatus*),

“Green snake.”

The specimens from the last-mentioned host were in bad condition, and their determination is questionable.

Genus **Echinocephalus**, Molin, 1858.

Echinocephalus spinosissimus (v. Linst., 1905).

A few mature, though rather small, specimens occurred in the spiral valve region of the intestine of *Trygon* (*Hypolophus*) *sephen* from the Chilka Lake on the East coast of India. The description of this species by Baylis and Lane (1920) necessarily omitted the measurements of the ova. The average size of the eggs in the present material is 0.05×0.0375 mm. The host is a new one.

Genus **Gnathostoma**, Owen, 1836.

Gnathostoma spinigerum, Owen, 1836.

Specimens occurred in a fishing cat (*Felis viverrina*) and in a leopard (*Felis pardus*).

Superfamily **TRICHINELLOIDEA**, Hall, 1916.

Family **TRICHINELLIDAE**, Stiles and Crane, 1910.

Subfamily **TRICHURINAE**, Ransom, 1911.

Genus **Trichuris**, Roederer, 1761.

Trichuris trichiura (L., 1771).

(Syn. *Trichocephalus dispar* auctt.)

Host: Gibbon (*Hylobates*, sp.).

Trichuris suis (Schränk, 1788).

(Syn. *Trichocephalus crenatus* auctt.)

Host: Wild pig (*Sus bengalensis*), near Dinapore, Bihar.

Trichuris ovis (Abildg., 1795).

(Syn. *Trichocephalus affinis* auctt.)

Host: “Antelope”—probably the Indian antelope or black buck (*Antelope cervicapra*).

Genus **Capillaria**, Zeder, 1800.

Capillaria columbae (Rud., 1819).

The collection contains a few specimens of this species, which were taken from the intestine of a pigeon in company with numbers of *Ascaridia columbae*. The worm has recently been redescribed by Irwin-Smith (1920) in Australia.

Superfamily **DIOCTOPHYMOIDEA**, Railliet 1910 (*fide* Travassos, 1920 [?])

Family DIOCTOPHYMIDAE, Railliet, 1915.

Genus **Eustrongylides**, Jägerskiöld, 1909.

Eustrongylides, sp. (?)

Two larvae taken from a prawn at Karachi by Dr. Baini Prashad, February 11, 1915.

These two specimens, which we refer tentatively to the genus, measure respectively 12.5 mm. and 13.25 mm. in length and 0.26 mm. and 0.33 mm. in maximum thickness. The head is somewhat swollen and almost globular in shape, with a maximum diameter of 0.21–0.22 mm. The mouth is situated in a large depression, on the border of which there are six small papillae. The second ring of papillae characteristic of the adults of *Eustrongylides* has not been detected. The oesophagus is of enormous relative length, measuring 7.9 mm. and 8.25 mm. in the two specimens, or about two-thirds of the total length. It consists of a short, narrow, muscular, anterior portion, measuring 0.43–0.45 mm. from the head-end, and a very long and considerably wider, glandular, posterior portion. The tail is short (0.13–0.15 mm.) and bluntly conical, with a little cuticular button at the extremity.

The life-history of the genus *Eustrongylides* and its allies is at present obscure, but it has been suggested that certain immature forms found in fishes are the larvae of *Eustrongylides ignotus* Jägerskiöld, a species occurring in various fish-eating birds. So far as we are aware, no form found in an invertebrate has hitherto been assigned to the genus.

Superfamily **STRONGYLOIDEA**, Weinland, 1858.

Family STRONGYLIDAE, Baird, 1853, *s.s.* Lane, 1917.

Subfamily **DELETROCEPHALINAE**, Raill., 1916.

Genus **Diaphanocephalus**, Diesing, 1851.

Diaphanocephalus willeyi (Linst., 1904) Railliet and Henry, 1909.

(Fig. 66.)

Syn. *Kalicephalus willeyi* Linst., 1904.

Examples of this species collected from the banded krait (*Bungarus fasciatus*) form part of the collection. The species was described from *Coluber helena* and *Vipera russellii* by von Linstow (1904) and has since been reported from *Typhlops braminus* by the same author (1906 *b.*) and from *Bungarus fasciatus* (1908). We have followed Railliet and Henry (1909) in regarding the genus *Kalicephalus*, Molin, 1861, as part of the genus *Diaphanocephalus*, Diesing, 1851.

From the generic diagnosis of *Kalicephalus* given by Molin (1861) it is apparent that this genus was separated from *Diaphanocephalus* on account of (*a*) the absence of the dorsal hump just anterior to the male bursa, and (*b*) the presence of a papilliform outgrowth carrying the vulva in the female. This combination of characters is not constant, as a reference to the descriptions of *D. willeyi* and *D. minutus*

will readily show. There is no appreciable difference in the structure of the mouth-parts, upon which it is usual to base new genera in this family.

The figure of *D. willeyi* is given in order to show the rudimentary "leaf-crown," or corona radiata, surrounding the entrance to the buccal capsule. The presence of

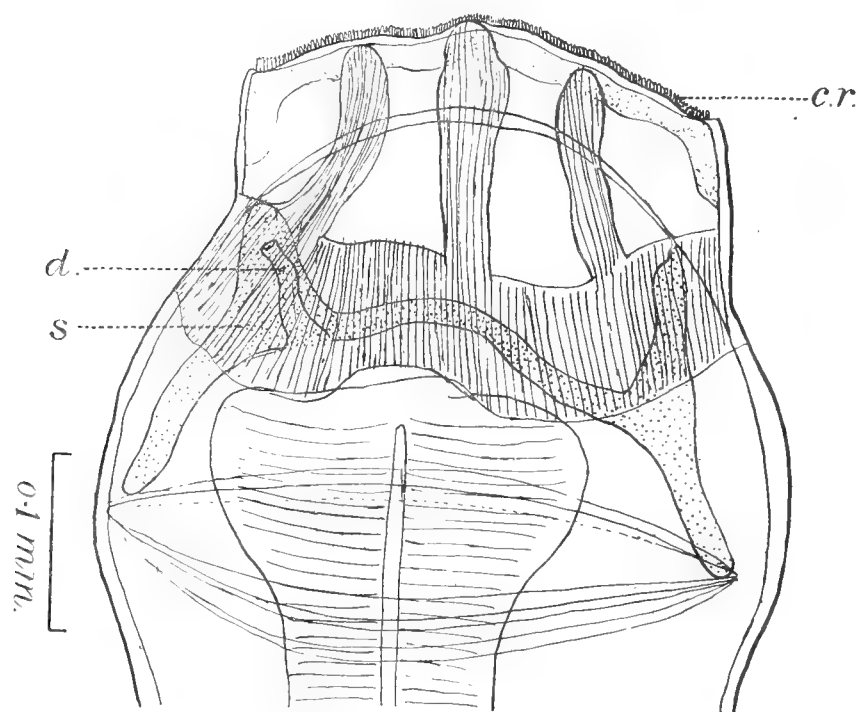


FIG. 66.—*Diaphanocephalus willeyi*. Head of female; lateral view.
c.r., corona radiata; d., duct of dorsal oesophageal gland; s., wall of buccal capsule (optical section).

this structure in a member of the genus *Diaphanocephalus* indicates a close proximity to the members of the subfamily Strongylinæ.

The genus *Diaphanocephalus* is here referred tentatively to Railliet's subfamily Deletrocephalinae, which, if we exclude the members of Skrjabin's genus *Kiluluma*, would appear to constitute a natural group.

***Diaphanocephalus minutus*, sp. nov.**

(Figs. 67–69.)

Host: Cobra (*Naja tripudians*).

This is the smallest species so far encountered in this genus. The males measure from 4.9 to 5.0 mm. in length and 0.2 mm. in thickness; the females from 5.1 mm. to 5.3 mm. and 0.21 mm. respectively. The dorso-ventral diameter of the head is 0.15 to 0.16 mm. The head is laterally compressed. There is a distinct constriction behind it. The mouth is furnished with three pairs of small papillae which are actually the terminations of the three pairs of longitudinal parenchymatous bands characteristic of the genus. These bands are lateral and spring from a collar which surrounds the base of the buccal capsule. The collar is in the form of a horseshoe with the open ends coming practically into apposition in the dorsal middle line. The buccal capsule is about 0.2 mm. deep and is thick-walled. When viewed in optical section in the

dorso-ventral position it is roughly oblong. The central portion of the cavity extends some little way into the oesophagus. The duct of the dorsal oesophageal gland projects for more than half the length of the buccal capsule. It is supported by the wall of the capsule, which is considerably thickened (figs. 67, 68) dorsally and ventrally at its base *s*. Viewed laterally, the buccal capsule appears roughly triangular, with the apex of the triangle directed backwards. The oesophagus is short and club-shaped, measuring about 0.45 mm. in length, whilst its maximum thickness is about 0.15 mm. The nerve-ring surrounds the oesophagus at about 0.09 mm. from its anterior end. The excretory pore opens at about 0.38 mm. from the head end in the male, and 0.44 mm. in the female. The bursa of the male is completely campanulate and not easily spread out. There are three lobes, two lateral and an unpaired dorsal. The main trunk of the dorsal ray (fig. 69) is extremely large, measuring about 0.2 mm. in length, and up to 0.07 mm. in thickness just before it gives off

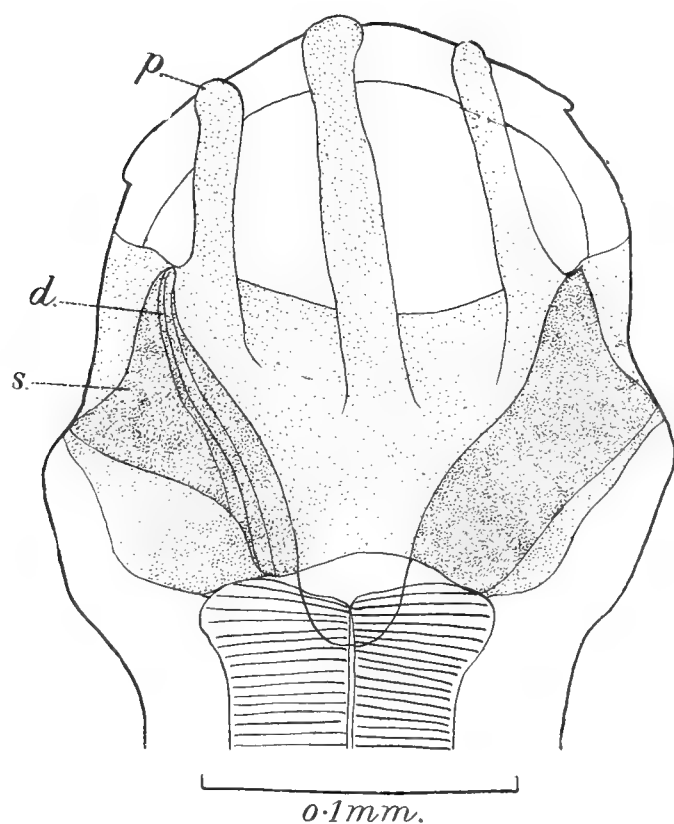


FIG. 68.—*Diaphanocephalus minutus*. Head of female; lateral view.

Lettering as in fig. 67.

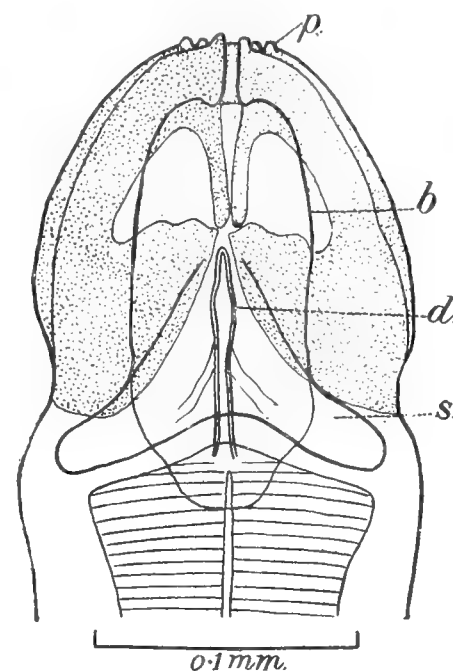


FIG. 67.—*Diaphanocephalus minutus*. Head of female; dorsal view.

b., wall of buccal capsule; *d.*, duct of dorsal oesophageal gland; *p.*, papilla; *s.*, wall of buccal capsule in optical section.

the large externo-dorsal rays. The latter are given off high up (about 0.16 mm. from the tip), and at a wide angle. Almost immediately behind this point the main trunk gives off a pair of stout, curved branches which together form a large horseshoe; the tips almost reaching the margin of the bursa. At its tip the dorsal ray divides into two short curved branches, the tips of which are again bifurcated. The lateral rays originate from a common root and reach almost to the edge of the bursa. The ventral rays are long and slender and closely applied to each other throughout their length. They reach the margin of the bursa. Just anterior to the origin of the bursa, there is a pair of latero-ventral papillae, which are stalked, and, though small, quite prominent.

The spicules are equal and slender and measure 0.255 to 0.275 mm. in length.

They are grooved on the ventral surface and slightly recurved at the tip. An accessory piece is absent. The anterior limit of the male genital tube is about 1.2 mm. from the head.

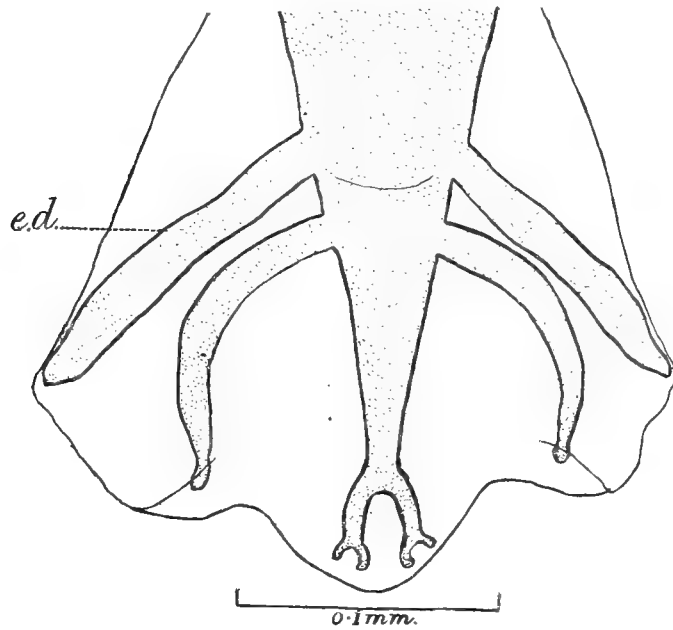


FIG. 69.—*Diaphanocephalus minutus*. Dorsal lobe of bursa; dorsal view.

e.d., externo-dorsal ray.

The tail of the female is drawn out to a rather acute point and measures 0.28 to 0.3 mm. in length. The vulva is situated in the posterior half of the body, dividing the latter in the proportion of 12.5 : 5. It is fairly prominent. There is a short vagina about 0.14 mm. long, running forwards, from which are given off two well-formed ovejectors which run anteriorly and posteriorly respectively. The combined length of the ovejectors is from 0.450 to 0.5 mm. The anterior uterus runs to within 0.8 mm. of the base of the oesophagus, whilst the posterior runs to within about 0.4 mm. from the tip of the tail. The anterior uterus is

commonly folded round the intestine, while the posterior has usually only a single bend. The ovaries commence at the points where the respective uteri bend, and run towards the middle of the body to cross each other just anteriorly to the vulva. The eggs in the uterus are thin-shelled, and measure 0.068 mm. in length by 0.031 mm. in breadth. Their contents are unsegmented.

Diaphanocephalus, sp.

One female in poor condition and a fragment of another female were collected from a cobra, *Naja tripudians*. The complete specimen is larger than the members of the preceding species, measuring 15.5 mm. in length and 0.43 mm. in thickness. The head, which is laterally compressed, measures 0.27 mm. in dorso-ventral diameter. The buccal cavity is 0.19 mm. deep. The structure of the head is similar to that described for *Diaphanocephalus minutus*. The oesophagus measures 0.485 mm. in length by 0.16 mm. in thickness. The vulva is situated in the posterior portion of the body, dividing it in the ratio of 6 : 5. Its lips are modified into a papilliform outgrowth which measures 0.141 × 0.08 mm. The ova in the uterus are thin-shelled and measure 0.065 × 0.045 mm. Their contents are unsegmented. The tail measures 0.45 mm. in length and is acutely pointed.

So far the only species described from the cobra is the preceding one, *Diaphanocephalus minutus*. The specimens under consideration differ from that species in their size and in the form of the vulvar opening.

Diaphanocephalus, sp.

Large numbers of females of a species of *Diaphanocephalus* were collected on nine different occasions from Russell's viper in Calcutta. There were no males.

The females measure from 16 mm. to 18 mm. in length and 0.46 mm. to 0.51 mm. in thickness. The head measures 0.225 mm. in dorso-ventral diameter, is laterally compressed, and is followed by a slight constriction. There are the usual three lateral pairs of parenchymatous bands, terminating anteriorly in three pairs of papillae.

The buccal cavity is similar in shape to that of *D. minutus* and is 0.21 mm. in depth. The oesophagus is *en masse* and measures 0.5 mm. in length and 0.22 mm. in maximum thickness. The nerve-ring surrounds the oesophagus at 0.35 mm. from the anterior end of the body. The excretory pore opens at 0.4 mm. from the head.

The vulva is situated in the posterior half of the body, dividing the latter in the ratio of 10.5 : 7. Its lips are modified into a papilliform process, the actual opening being on the summit of the papilla. This "papilla" is smaller than in the preceding species, measuring 0.095 × 0.085 mm. There is a short transverse vagina, at right angles to which the well-developed anterior and posterior ovejectors are given off.

The eggs in the uterus are unsegmented and measure 0.080 × 0.048 mm. The anus is situated at 0.72–0.75 mm. from the tip of the tail, which is drawn out to an acute point.

Discovery of the males may prove that this species and the foregoing are identical. The differences observed in the single specimen from the cobra are too slight to warrant definite separation.

Family ANCYLOSTOMIDAE, Looss, 1911.

Subfamily *ANCYLOSTOMINAE*, Looss, 1905, *emend.* Lane, 1917.

Genus *Ancylostoma* (Dubini, 1843) Creplin, 1845.

The collection contains all the species of this genus known to occur in India. These are fairly well-known, and we propose only to give lists of the hosts from which they were collected, with brief comments where necessary.

Ancylostoma duodenale (Dubini, 1843).

Hosts:

Tiger (*Felis tigris*).

Fishing cat (*Felis viverrina*).

Lane (1917 *b*) has given an account of the occurrence of this species in the tiger. He observed that the specimens, though mature, were somewhat stunted in size, which may be an indication that the worm, now occurring mainly as a human parasite, finds the conditions of living in the tiger adverse to the attainment of its full size. The same failure to reach the normal size is observable in the material in the present collection. From the tiger there are several specimens of both sexes; from the fishing cat only a single female. The fact that this species can live in wild Felidae indicates that it may eventually be discovered in the domestic cat (*cf. A. caninum* and *A. ceylanicum*).

Ancylostoma caninum (Ercolani, 1859).

Hosts :

Wild dog (*Cyon dukhunensis*).
Indian wolf (*Canis pallipes*).
Indian jackal (*Canis aureus*).
Indian fox (*Vulpes bengalensis*).
Indian desert fox (*Vulpes leucopus*).
Sloth-bear (*Melursus ursinus*).
Tiger (*Felis tigris*).
Leopard (*Felis pardus*).
Fishing cat (*Felis viverrina*).
Domestic cat.

Ancylostoma ceylanicum, Looss, 1911.

Hosts :

Civet (probably *Viverricula malaccensis*).
Tiger (*Felis tigris*).
Lion (*Felis leo*).
Leopard (*Felis pardus*).
Fishing cat (*Felis viverrina*).
Leopard cat (*Felis bengalensis*).
Domestic cat.
Wild dog (*Cyon dukhunensis*).
Indian wolf (*Canis pallipes*).
Sloth-bear (*Melursus ursinus*).
Red cat-bear (*Aelurus fulgens*).

Ancylostoma malayanum, Alessandrini, 1905.

Hosts :

Malay bear (*Ursus malayanus*).
"Bear"—probably the Sloth-bear (*Melursus ursinus*).

Genus **Galoncus**, Railliet, 1918.**Galoncus perniciosus** (v. Linstow, 1885) Railliet, 1918.

The collection contains one female only of this species, collected from the intestine of a leopard (*Felis pardus*) in the Zoological Gardens, Calcutta.

We have nothing to add to the description given by Railliet beyond remarking that the head is evidently retractile, and in the extended state the buccal capsule appears relatively much larger in proportion to the width of the body of the worm. The specimen figured by Railliet (1918) is in the retracted state. Doubtless the powerful muscles attached to the lateral walls of the buccal capsule, which were noticed by Railliet and other authors, are connected with the retraction of the head.

This genus appears to form a link between the subfamilies Ancylostominae and Necatorinae.

Subfamily *NECATORINAE*, Lane, 1917.

Genus *Necator*, Stiles, 1903.

Necator americanus (Stiles, 1902).

We have to record the occurrence of this species in a new host, *viz.* a young African rhinoceros* (*R. bicornis*), which had lived in the Zoological Gardens, Calcutta for a very short time. The animal was captured in the Tanganyika Territory (formerly German East Africa) and was brought to India by Mr. E. W. Harper, to whom we are indebted for this information.

Careful comparison of this material with specimens of *Necator americanus* from man in the collection of the British Museum reveals no difference except that the female specimens from the rhinoceros are slightly the longer. They measure from 11 to 13 mm. in length and 0.4 mm. in thickness, as against 10 to 12 mm. and 0.4 mm. respectively in the case of the specimens from man.

The subfamily Necatorinae was proposed by Lane (1917 *a*) to replace the older subfamily Bunostominae, Looss, 1911. The difference between these two groupings is that, according to Lane, the genus *Uncinaria* approaches more nearly to the *Necator* and *Bunostomum* group than to the Ancylostominae, among which it was placed by Looss. It is interesting to recall that of the subfamily Necatorinae, if *Uncinaria* be left out of account, all the members except *Necator* occur in herbivorous animals only,¹ and, in consequence, the occurrence of *Necator* in the rhinoceros is not so astonishing as it might appear at first sight. All the species of *Ancylostoma* occur in carnivores, and all except *Ancylostoma duodenale* and *A. ceylanicum* in carnivores only. It seems probable, therefore, that the original hosts of the species now found in man were carnivores. It is also almost certain that *Necator americanus* was introduced into America with the African slaves, and if this is the case, man may have acquired his earliest infestations with this parasite from some wild herbivore inhabiting Africa.

Family TRICHOSTRONGYLIDAE, Leiper, 1912.

Subfamily TRICHOSTRONGYLINAE, Leiper, 1908.

Genus *Haemonchus*, Cobb, 1898.

Haemonchus contortus (Rud., 1803).

This species occurred in the Markhor (*Capra falconeri*) in the Zoological Gardens, Calcutta.

Haemonchus cervinus, sp. nov.

The collection includes several females of a species of *Haemonchus* from a spotted deer (*Cervus axis*). The specimens are in poor condition. They measure from 13 to

¹ Since the preparation of this paper, *Necator* has been recorded from the pig in Trinidad (Ackert and Payne, *Amer. Jl. of Hyg.*, 11, 1, Jan., 1922). The authors regard the form found in pigs as a new species, which they have named *N. suillus*.

15 mm. in length and up to 0.4 mm. in thickness. The body tapers uniformly anteriorly to a small head which measures 0.023 to 0.025 mm. in diameter. The mouth contains the single small lancet characteristic of the genus. The cervical spines are situated at about 0.37 mm. from the anterior end. The oesophagus is slender, and measures about 1.2 mm. in length. It is encircled by the nerve-ring at about 0.25 mm. from the anterior end. The excretory pore is just behind the level of the nerve-ring.

The vulva is slightly prominent, but possesses no overhanging anterior lip such as is found in *H. contortus*. It is situated at about 11 mm. from the anterior end. There is a short, transverse vagina, from which well-developed anterior and posterior ovejectors are given off. The eggs in the uterus measure 0.08–0.09 mm. \times 0.04–0.05 mm., and their contents are unsegmented. The tail is long and slender. The anus is situated at about 0.37 mm. from the tip.

In addition to the females this batch of specimens includes one male. The bursa of this specimen is incomplete, and the whole worm so badly damaged that we have found it impracticable to give a description of the male.

Family METASTRONGYLIDAE, Leiper, 1908.

Subfamily RICTULARIINAE, Hall, 1913.

Genus *Rictularia*, Fröl., 1802.

Rictularia, sp.

A single female specimen, taken from the intestine of a palm-civet (*Paradoxurus hermaphroditus bondar*,¹ though labelled "*Paradoxurus niger*"), caught in the Museum compound, Calcutta.

Rictularia plagiostoma (Wedl) has been recorded as a parasite of a palm-civet by Leiper.² The present specimen, however, does not agree with the careful description of *R. plagiostoma* given by Jägerskiöld (1909), and we refrain from attempting to attach a specific name to it.

Fam. incert.

Genus *Scolecophilus*, nov.

Scolecophilus lumbricicola, sp. nov.

(Figs. 70, 71.)

Host: an earthworm (*Perionyx m'intoshi*, Beddard). Locality: Nepal Valley.

This nematode was found by Dr. J. Stephenson in the body-cavity of the host, in the tenth and eleventh segments. He noted that in the former segment they were surrounded by masses of what appeared to be the spermatozoa of the host. The material is not in a perfect state of preservation, having, no doubt, been removed from the host after death. We are unable, therefore, to give a very complete account of the anatomy. The species, however, shows certain remarkable features which make it worthy of a brief description.

¹ See Robinson and Kloss, *Rec. Ind. Mus.*, XIX, Part IV, 1920, p. 178.

² *Proc. Zool. Soc. London*, 1911, p. 620.

The male measures 3.65–4.15 mm. in length and 0.4–0.5 mm. in thickness; the female 6.0–6.5 mm. and 0.5–0.6 mm. respectively. In general shape (fig. 70) the worms are rather short and stout. The male has its blunt tail strongly curled ventrally, while the posterior end of the female is straight and conical. The anterior end tapers more gradually than the posterior. The cuticle is thin and smooth, except in the region of the lateral fields. These are very conspicuous, being very broad and of a granular appearance, and the cuticle covering them, especially near the anterior and posterior ends, is thrown into strongly-marked transverse furrows. The width of the lateral fields is about 0.1 mm. anteriorly, increasing posteriorly to about 0.22 mm. Near the tail they bend round towards the ventral surface. The musculature is apparently of the meromyarian type. The head is somewhat abruptly truncate. The mouth shows no recognizable lips or papillae. The oesophagus is slender, passing posteriorly into a relatively large, glandular bulb of almost oblong shape. The entire oesophagus, including the bulb, is 0.7–0.76 mm. long in the male, 0.8–0.9 mm. in the female. The bulb measures about 0.35 mm. in length and 0.17 mm. in diameter. It is connected with the intestine by a narrow neck containing some kind of valvular apparatus. The intestine is apparently modified into a “fat-body” somewhat resembling that of the Mermithidae. An anal aperture appears to be absent, the intestine terminating blindly behind. The nerve-ring is situated at about 0.13 mm. from the anterior end. No excretory pore has been seen.

In the male, there are paired spicules and an accessory piece. The shape of the spicules is highly characteristic, and is more readily conveyed by a figure (fig. 71) than by description. Each spicule is broad at the base, and bent at right angles at about its middle. In the males examined, the spicules were protruded as far as the bend, and had their tips directed laterally, as shown in the figure. The tip of each spicule is bifurcated, ending in two sharp points of slightly unequal length, separated by a deep cleft. The spicules measure 0.18 mm. in length (following the bend). The dorsal portion of the accessory piece is roughly triangular, broader behind than in front, and appears to send down lateral processes at the sides of the spicules. No caudal papillae have been made out.

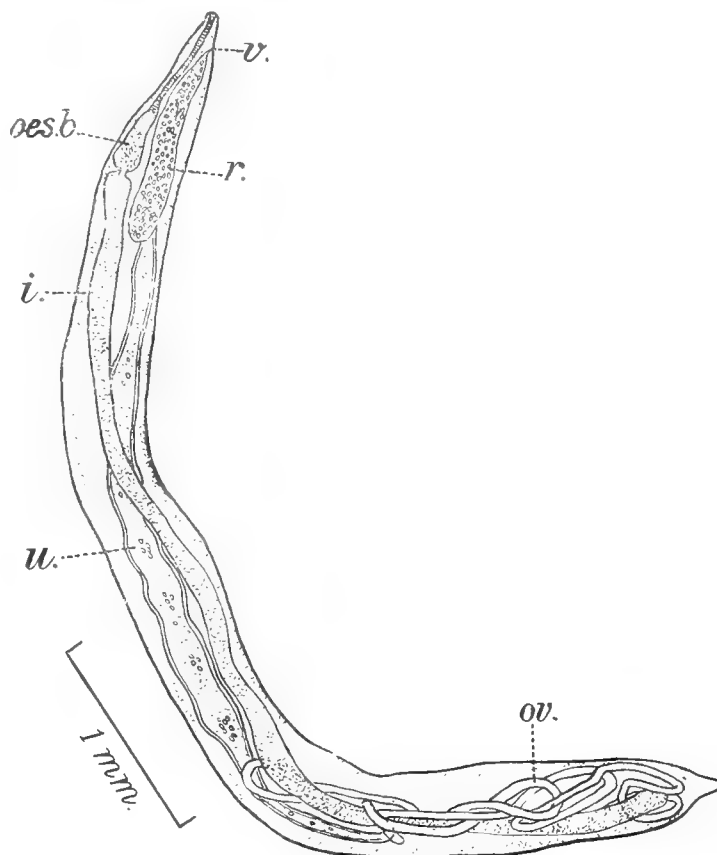


FIG. 70.—*Scolecophilus lumbricicola*. Female; lateral view.

i., intestine; *oes.b.*, oesophageal bulb; *ov.*, ovary; *r.*, rudiment of second uterus; *u.*, functional uterus; *v.*, vulva.

In the female, the vulva is situated at about 0.18 mm. from the anterior end. Its position is usually marked by a sudden change in the diameter of the worm, the portion anterior to it being much narrower than the rest of the body. The general arrangement of the female organs is shown in fig. 70. There is no ovejector or muscular vagina. Only one genital tube is complete and functional. The uterus runs back almost straight for some three-quarters of the length of the body, and shows little accumulations of imperfectly-formed ova here and there along its course.

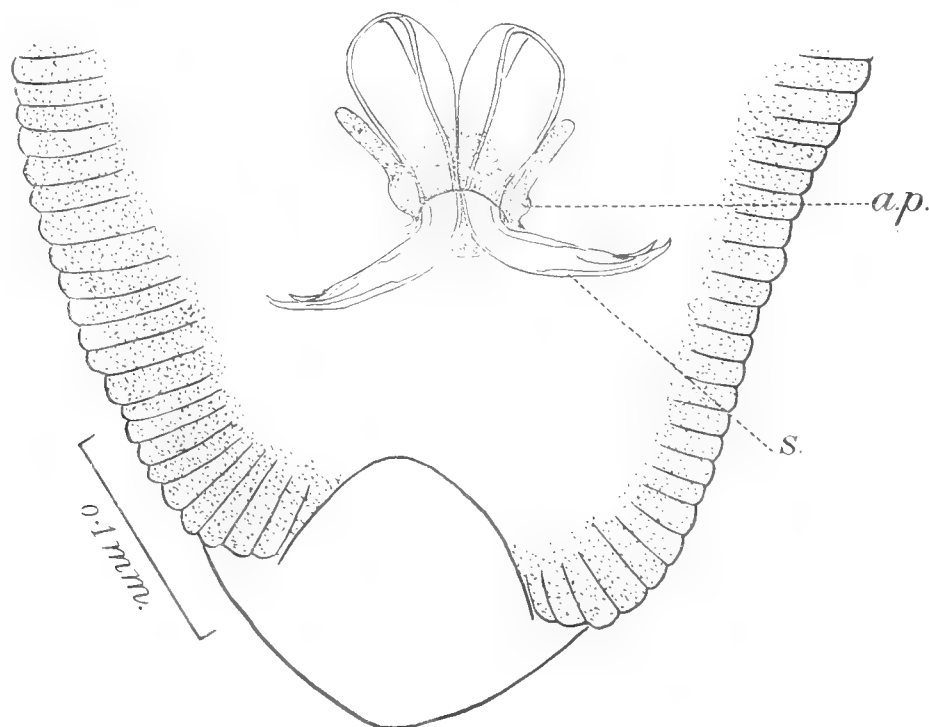


FIG. 71.—*Scolecophilus lumbricicola*. Tail of male; ventral view.
a.p., accessory piece; s., left spicule.

The coils of the oviduct and ovary are confined to about the posterior third of the body. The other uterus appears to be represented by a blind sac, lying alongside of the anterior portion of the functional uterus, and serving as a reservoir in which the fully-formed ova are stored before being laid. This sac may run back, in large specimens, to a point about 2.5 mm. from the anterior end, and is generally crowded with eggs. These are of oval shape, with a thin shell, measuring about 0.065×0.038 mm., and containing a crescentic embryo.

The absence of one branch of the uterus is not uncommon among nematodes, and is most frequently seen in cases where the vulva has been displaced far from its "primitive" median position towards either of the extremities of the worm. This modification is met with among certain free-living forms, as well as in several families, or isolated genera and species, of nematodes parasitic in vertebrates. But there is one group of forms (all of which are, at least during a certain phase of their existence, parasitic in invertebrates), to which the present form is perhaps most closely related. This is the group including *Allantonema*, *Atractonema*, *Bradynema* and *Sphaerularia*. These forms are generally placed among the Mermithidae, though it seems doubtful whether such a classification would bear critical examination. They do, at all events, share with *Mermis* and its close allies, with the present species, and with one or two other isolated genera (*Aprocta*, *Aproctonema*), the peculiarity of having no posterior opening to the intestine in the adult form. The alimentary canal is, moreover, in these forms, either

entirely absent in the adult female, or reduced, as in the Mermithidae, to a more or less solid organ functioning as a reserve of food-material. Again, in all these forms the female genital apparatus is reduced to a single uterus and ovary. The vulva, however, is not anteriorly but posteriorly situated. The worms are either protandrous hermaphrodites, or the sexes are separate, only the females and young larvae being parasitic. A position in some respects intermediate between the present form and the group referred to might perhaps be assigned to the genus *Aproctonema*, Keilin, 1917. This is represented by *A. entomophagum*, Keilin, of which the separate sexes are both parasitic in the larvae of a Dipterous insect. The oesophagus of *Aproctonema* has a somewhat similar structure to that of *Scolecophilus*. The intestine (which has an anterior diverticulum), is a solid "fat-body", and has no posterior opening. There are two opposed uteri in the female, and the vulva is situated somewhat behind the middle of the body.

A sac-like vestige of the second uterus, somewhat like that described above for *Scolecophilus*, has been observed in *Sphaerularia*, and also in some of the free-living "monodelphic" forms. It appears in some cases to act as a receptaculum seminis rather than a reservoir for developing eggs, but possibly it serves both purposes.

FORMS OF FREE-LIVING (ANGUILLULID) TYPE.

Genus **Cephalobus**, Bastian, 1865.

Cephalobus seistanensis, sp. nov.

(Figs. 72, 73.)

A number of minute nematodes were collected by Dr. N. Annandale and Dr. S. W. Kemp from the tissues of the water-snail, *Gyraulus convexiusculus*, in reed-beds in the Hamun-i-Helmand, Seistan, E. Persia. These specimens may have been in the pulmonary cavity. They had a reddish colour when alive, like that of the blood of the mollusc. They probably belong to the genus *Cephalobus*, of which one member, *C. bütschlii* de Man, is known to be, at least at times, a parasite of certain fresh-water snails (*Succinea*), though most of the species are free-living or to some extent parasites of plants.

The present species has a length of 0.95–1.08 mm. in the male and 1.3–1.43 mm. in the female. The maximum thickness of the male is about 0.025 mm., of the female 0.035 mm. The oesophagus is from 0.2 to 0.27 mm. long, and is composed of a long anterior muscular portion, narrow anteriorly and posteriorly, but somewhat swollen for about the middle third, and a rather elongated, fusiform, posterior glandular portion, or bulb, of larger diameter. This bulb is not distinctly marked off from the rest of the oesophagus. The nerve-ring surrounds the muscular portion at the back of its swollen middle region.

The caudal end of the male is strongly coiled ventrally. The tail is 0.05 mm. in length and tapers sharply to a fine point. There are two equal, broad spicules, 0.026 mm. long,

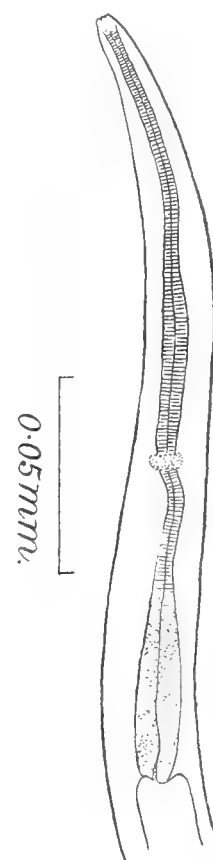


FIG. 72.—*Cephalobus seistanensis*. Anterior end.

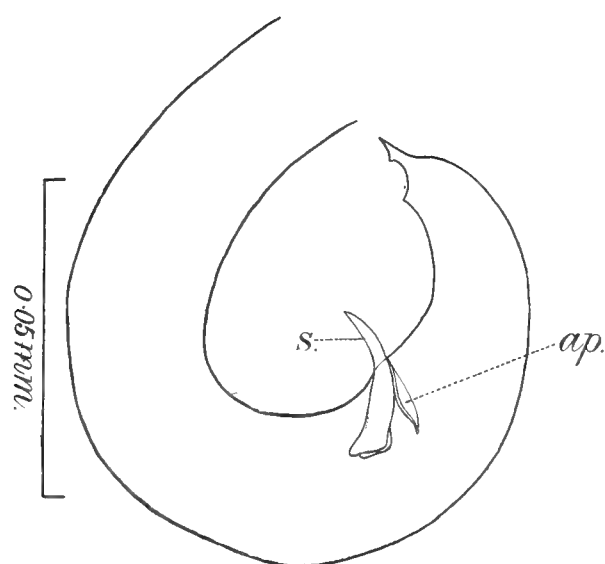


FIG. 73.—*Cephalobus seistanensis*. Posterior end of male; lateral view.

a.p., accessory piece; *s.*, right spicule.

and an accessory piece 0.015 mm. long. The only caudal papillae appear to be two small ventral pairs near the extremity of the tail.

The tail of the female is tapering, 0.08 mm. long, and curves towards the dorsal side. The vulva opens at about 0.55 mm. from the posterior end, *i.e.* somewhat behind the middle of the body. The single genital tube runs forward for about 0.3 mm., and then doubles upon itself to run straight backward, the blind end of the ovary being situated at about 0.1–0.15 mm. behind the vulva. The uterus, in mature females, never seems to contain more than one fully-

formed ovum at a time. Such ova have an unsegmented content and measure 0.045 × 0.025 mm.

The relative dimensions of this species, expressed according to the formula of de Man, would be somewhat as follows: $\alpha = 38-40.85$; $\beta = 4.75-5.3$; $\gamma = 19$ in male, 17.8 in female.

Genus *Monhysterides*, nov.

Monhysterides piscicola, sp. nov.

(Figs. 74, 75.)

Host: Mahseer (*Barbus tor*). Locality: Torsa River, Falakata, Eastern Bengal.

This is a very small form, the male measuring 3.5–4.0 mm. in length, the female 3.7–4.4 mm. The maximum thickness is 0.15–0.2 mm. The body is slender and tapering towards each extremity, the middle region being relatively stout. The diameter of the head is 0.03–0.04 mm. The cuticular striation is exceedingly fine. Owing to the very small size of the head the characters of the mouth are difficult to determine. It appears to be surrounded by six small nodules, two of which are probably lateral, two subdorsal and two subventral. There are indications of minute papillae near their bases. The oesophagus consists of a short anterior portion which is transparent and purely muscular, about 0.2 mm. long, and a longer posterior portion which is partly glandular and partly muscular, and is swollen behind. This portion may

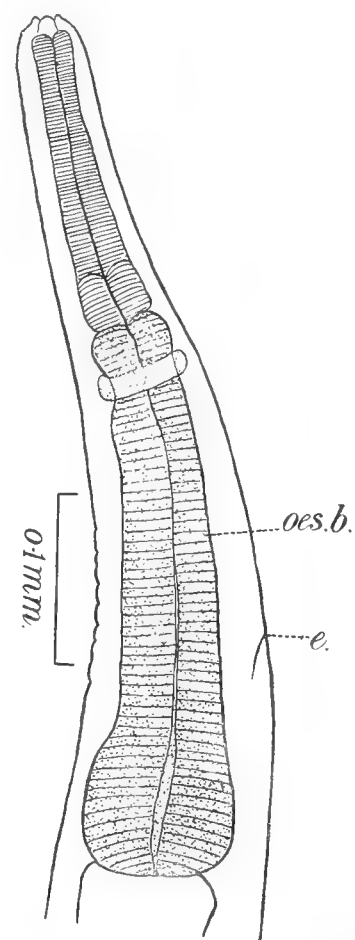


FIG. 74.—*Monhysterides piscicola*. Anterior end of female; lateral view.

e., excretory pore; *oes.b.* oesophageal bulb.

probably be regarded as a pear-shaped bulb of an unusually elongate shape. It measures about 0.32 mm. in length and 0.065–0.09 mm. in thickness posteriorly. The anterior, muscular portion of the oesophagus appears to be divided transversely near its posterior end, by a kind of diaphragm, into two parts of slightly different histological appearance. The nerve-ring surrounds the neck of the “bulb” (not the muscular part of the oesophagus, as is usually the case), near its origin, *i.e.* at about 0.22 mm. from the head-end of the worm. The excretory pore is situated at about 0.4 mm. from the anterior end.

In the male, the tail measures 0.34 mm. in length, and tapers to a very fine point. There are two very unequal tubular spicules, of which the left measures 0.21 mm. in length, the right 0.08 mm. The tip of the long spicule is bluntly rounded, that of the short spicule more pointed. There is no accessory piece. There are nine pairs of caudal papillae, of which four are preanal and five postanal. The preanal papillae are all very close together, near the cloaca, and these and the most anterior pair of postanal papillae are very large and prominent, projecting ventrally. Of the remaining postanal pairs, which are smaller, one is laterally situated, not far from the cloaca, and the rest form a triangle, two being ventral and one lateral, at about the middle of the tail.

The female has a finely tapering tail, 0.55–0.65 mm. long. The vulva is situated at about 0.45 mm. in front of the anus, and the uterus and ovary are single. The latter is situated anteriorly, and is reflexed at about 1.2 mm. from the anterior end. The worm is viviparous, the embryos being at first enclosed in large, oval, membranous shells, measuring 0.275 × 0.125 mm., but subsequently hatching *in utero*. The voluminous uterus may contain at one time some 15 to 20 eggs containing embryos in various stages of development, and about four or five free embryos. The latter are about 1 mm. long, or roughly a quarter of the length of the parent.

The systematic position of this species is somewhat doubtful, but we are inclined to regard it as a member of the usually free-living family Anguillulidae that has recently taken to a parasitic mode of life. It does not show the specialization of the female genital apparatus which usually takes place in true internal parasites. One of us (Baylis (1915)) has described two semi-parasitic species apparently belonging to the genus *Monhystera*, and it is to this genus that the present form seems to approach most closely in its general anatomy.

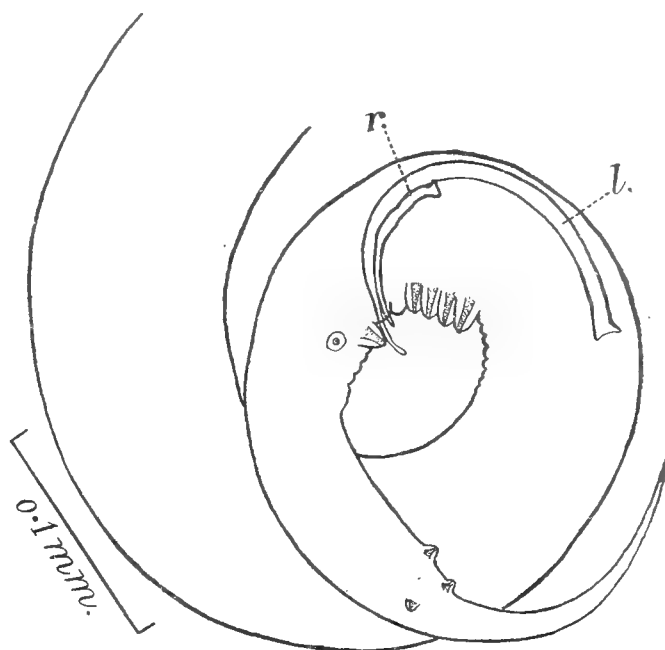


FIG. 75.—*Monhysterides piscicola*. Posterior end of male; lateral view.

l., left spicule; *r.*, right spicule.

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